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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

JANUARY 7.

Wales and Monmouth Branch:—Ordinary meeting at Newport. "Some Aspects of Oil-Engine Foundry Practice," Paper by H. E. Beardshaw.

East Midlands Branch (Lincolnshire Section):—Ordinary meeting at Lincoln. "The Application of Pulverised Fuel," Paper by W. Boon.

Lancashire Branch:—Ordinary meeting at Manchester. "The Effects of Phosphorus on Low Total-Carbon Cast Irons," Paper by W. West.

JANUARY 12.

London Branch:—Ordinary meeting. "Cost Accounts for the Light Casting Iron Foundry," Paper by A. Young.

JANUARY 14.

Scottish Branch:—Ordinary meeting at Glasgow. "The Sand-Spun Pipe Plant of the Staveley Coal & Iron Company," Paper by J. B. Allan.

Cylinder Liner Wear.—II.

The discussion on the Paper on cylinder wear to which we have previously referred, by Engineer Rear-Admiral J. Hope Harrison, is well worth perusal by those concerned with cylinder and liner manufacture. It is just as impossible to summarise the discussion as to summarise the Paper. Mr. P. H. Smith attempted to do the latter in the following words: "Given right materials as between cylinder, piston and rings, then cylinder wear is a minimum when the lubricant passes through the system with the minimum cracking, provided it is introduced between the ring face and cylinder wall." This speaker regarded as fallacious the idea that pressure behind the rings is the prime cause of wear, and appears to suggest that the cause of cylinder wear is the inability to obtain a lubricant which will retain its properties at the temperatures and pressures reached in an engine without serious cracking.

Another speaker suggested as ideal conditions for liner wear a thin liner of 300 to 350 Brinell hardness with piston rings of 180 Brinell hardness, and having a thickness of not less than 1/40th of the cylinder bore. Some part of the discussion concerned the methods and instruments by which wear is measured. With respect to materials, the possibility of irons of martensitic structure was mentioned. Another speaker, summarising the Paper and discussion, gave five factors as influencing wear: Piston-ring pressure; piston speed; temperature conditions of liner, piston and rings; lubrication; and erosion; and after further examination suggests that the main controllable cause of unusual rates of wear is variation from the normal in the relative temperature conditions of piston, piston rings and liner surfaces. A further useful suggestion was made—that engineers and metallurgists should co-operate in considering specific reports on liner wear.

We have elaborated some of these points to show that discussion among experts suggests that liner wear is due much less to the actual material employed than to other conditions which are met in service, and unless experimental work on wear and attempts to explain the cause of excessive wear keep these points in mind little further progress is likely to be made. The problem will not be solved by engineers and metallurgists working in mutually exclusive and watertight compartments, and the sooner provision is made for an attack on this question the quicker is a definite result likely to be achieved.

Technocracy.

We have seen no definition of this word, but it relates to a theory that modern engineering practice has produced a kind of Frankenstein monster which in the near future is to end civilisation. It is sponsored by a group of irresponsible "engineers" living in "Greenwich Village"—the "Montmartre" quarter of New York. The new theory has received world-wide publicity because of the statements which have appeared in the first issue of the "New Outlook" under the editorship of Governor "Al" Smith. This article contains a number of ridiculous assertions such as "In [American] pig-iron production one man working one hour can do what it took him 650 hours to accomplish 50 years ago." An examination of this statement by the Editor of "The Iron Age" shows that if this were true no less than 1,050,000 persons would have been engaged in iron production in 1879, whereas actually there were 41,695. An analogous statement about employment in rolling mills is equally futile. "In agriculture," state the technocrats, "one man can do in one hour what he required 3,000 hours to accomplish in 1840." It is admitted that this, the least mechanised industry of all, is at the moment worse off than the most progressive regarded from the angle of unemployment. Coffee, cotton, wool and meat are not seriously mechanised, yet over-production is equally evident amongst these raw materials.

To our mind mass production is less to blame than the sales methods adopted in America during the industrial boom. This policy induced far too many individuals to mortgage their future incomes, which failed to materialise, associated with the sterilisation of gold in the banks of Paris and New York, war debts, reparations, and because of their combined effect on the commodity markets, a universal feeling that if one refrains from buying for a short period one will purchase goods more cheaply.

There is nothing in the outcry of the "technocrats" to assail the well-established argument that by producing more cheaply the potential number of buyers is increased and a contribution is made to the welfare and progress of humanity. American industrial indigestion is due to a very large number of people having bitten off more than they could comfortably chew.

Siemensite Refractory for Basic Open-Hearth Furnaces.

USE IN CONJUNCTION WITH SHORT PORT BLOCK AND COOLING FRAME.

In Report No. 237 of the German Ironmasters' Association's Steelworks Committee, published in a recent issue of "Stahl und Eisen," J. SITTARD gave the results of experience in the use of Siemensite for the ports, uptakes, end and back walls of basic open-hearth furnaces.

Siemensite is a highly-refractory material obtained by reduction fusion in an open arc furnace. The substances from which it is produced are chromite, bauxite and magnesite. The composition of the mixture charged is adjusted to give approximately the following composition in the melted mass:—Cr_2O_3, 20 to 40 per cent.; Al_2O_3, 25 to 45 per cent.; MgO, 18 to 30 per cent.; balance, 8 to 14 per cent. The principal constituents, chromium oxide, alumina and magnesia are present as spinel. The remaining materials combine with a small portion of the principal constituents to form silicates. Cast bricks are produced by pouring the molten mass into moulds, the bricks being subjected to a tempering process in a tunnel furnace to relieve casting and cooling stresses.

The most important properties of the Siemensite bricks according to the tests so far available are:—Refractoriness, above Seger Cone No. 42; softening point under a load of 2 kgs. per sq. cm. (28½ lbs. per sq. in.) over 1,800 deg. C.; density, including pores, 3.2 to 3.4; heat conductivity, not yet exactly determined, but higher than that of magnesite; expansion between 0 deg. C. and 1,200 deg. C., 1.2 to 1.4 per cent., at higher temperatures about 2 per cent. Siemensite bricks are highly resistant to acid and basic slags at low and high temperatures.

Experiments on the use of Siemensite as a building material for open-hearth furnaces were commenced at the beginning of 1928 at the Weber steelworks and rolling mills in Brandenburg. At first it was built in as broken pieces. After attempts to make bricks by crushing the slag and moulding this with the addition of a binder had failed, rough bricks were cast, which at the start proved excessively brittle. This was overcome by annealing after casting.

For more than eight years the Weber works have employed a scrap-carbon process in which the steel and furnace temperatures are higher than for other processes, while the periods during which the higher temperatures must be maintained are also longer. In addition the charge normally consists of light, rusty mixed scrap, with occasionally very appreciable quantities of turnings and runners. The weight of the charge has been increased from the former 50 tons to 150 tons. A specially short port block has been developed which has to be kept unaltered during the furnace campaign. The furnaces are heated by producer gas (from hard coal), and after melting, a long flame is maintained, combustion not being completed before the flame reaches the outgoing ports.

The block was fitted with a cooling frame made of various kinds of refractory materials, extending down the sides and over the top of the gas port, at the front end of the latter. In spite of the cooling effect, the refractory cover of this cooler melted away in a short time, the exposed cooler then adversely affecting the operation of the furnace. The tongue piece separating the gas and air ports was then covered with Siemensite. After the production of only 12,000 tons, however, the uncooled silica arch over the gas uptake melted away, the Siemensite on top falling through and leaving a clear hole through. The length of the cooler was then extended to reach into the end wall of the block, over the top of the uptake, and the whole covered on top with pieces of Siemensite, there being a silica arch beneath the cooler. The life thereupon obtained gave a production of 102,000 tons of steel.

With this construction the cooling frame in the first place prevented the burning through of a hole; on the other hand, it was the almost unlimited durability of Siemensite in this position that permitted the use of such a large cooler without heavy loss of heat. The gas ports and the dividing tongues are now made thus on all the furnaces and no longer cause any trouble.

Foreign Pig-Iron in the United States.

The statistics relating to imports of pig-iron into the United States during the first eight months of 1932 are unusually interesting, according to the "American Metal Market," as showing a shifting in foreign sources from British Indian to Dutch iron. In the same period there was also an appreciable increase in imports from the United Kingdom and a small increase in the imports of Swedish iron. The changes in the American imports from other countries are of minor importance.

Imports from all foreign countries in 1932 up to and including August aggregated 83,074 tons, against 65,093 tons in the corresponding period of last year, a net gain of nearly 18,000 tons. Arrivals of Dutch iron alone this year amounted to 36,401 tons against last year's imports of 6,245 tons, or a net gain of 30,156 tons. Imports from Great Britain increased from 2,306 tons in 1931 to 16,402 tons this year, a net gain of a little over 14,000 tons. There was also a net gain of 1,804 tons in Swedish iron imports.

On the other hand, there was a fall of 26,636 tons in the imports of British Indian iron, that is, from 50,580 tons in 1931 to 23,944 tons in 1932. There were also minor reductions in imports from Canada, Belgium, Norway and from other countries.

The shift from Indian to Dutch iron is accounted for by the relatively low prices at which Dutch iron has been available. Now a new factor is coming into the market, that is, offerings of Japanese pig-iron at low prices. It is understood that a pipe works on the Delaware River has placed a small order, of 100 tons, with a Japanese interest to test the quality of the iron offered. According to reports from Philadelphia, orders are being solicited at extremely low prices, lower than those at which Dutch iron has been sold, probably as low as $11.50 to $12 eastern seaboard, duty paid. The low offerings are said to be made possible by the low rate of exchange for the yen.

CONTRIBUTIONS TO INFIRMARIES and other charitable contributions have been made by employees of the following firms during 1932:—Messrs. Bairds & Dalmellington, Limited, Muirkirk, £681; Messrs. Jones & Campbell, Limited, Torwood Foundry, Larbert, £278; Messrs. Pather Iron & Steel Company, Limited, Wishaw, £68; National Steel Foundry Company, Limited, Leven, £63; Messrs. Fleming, Reid & Company, Limited, Dalry, £110.

MOTHERWELL AND COATBRIDGE FIRMS are to share contracts placed by the Iraq Petroleum Company and the L.M.S. Railway Company respectively. A contract worth £160,000 has been placed by the Iraq Petroleum Company with the Motherwell Bridge & Engineering Company, Limited, Motherwell, and the Whessoe Foundry & Engineering Company, Darlington, for the manufacture of petroleum storage tanks for erection at Haifa, Palestine. The two companies share the contract equally, which involves the use of 8,000 tons of British steel. The L.M.S. Company have placed an order with Messrs. William Baird & Company, Limited, Lochrin Ironworks, Coatbridge, for extensions to the goods shed at Watford.

Random Shots.

Shots at random land sometimes one knows not where. Sometimes they set a relay going which sets off other relays, which set off others; and the shot which was once randoming finds a course set straight for a bull's-eye. Thus the other day at the Scottish Branch Annual Dinner two speakers on the Toast List, proposer and responder respectively to one Toast, embellished their speeches something as follows:—

Said the Toast-proposing Scott (two t's, please, Mr. Printer): "Asking the Hon. Secretary what were the interests of the Responder to this Toast, he informed me he was an Egg Dealer!"

In due turn, the responding Scot: "Though I am, as our friend has said, an Egg Dealer, I am primarily a Provision Merchant; just as he is, primarily, a founder and, secondarily, a Pipe Seller!" The responder apparently held the remarkable belief that all castings were not solid.

Going to bed in the late hours of the following morning, I had a dream. I was still at the Dinner. Those two, Scott and Scot, were still biffing away at each other between reconsumations of the Toast. I was busy with the wine waiter, but their words came through just as I was ordering two jeroboams of Bollinger.

The Proposing Scott: Yes, but Eggs! EGGS!!!

The Responding Scot: Well, how about your selling pipes without bags to a Scotsman? Why don't you set up also a tailor's shop and do the thing properly?

The P.S.: Haway man! You don't know your friends. I boss a show down in England, where customers insist on paying for all they get, and when we feel like giving a few pipes away—for nothing—we just breathe a word across the Borrderr, and a hole is made in our supplies bigger than any we put in.

The R.S., fainting: What emptiness!

The P.S., dying: Eggsactly!

* * *

Coming back to the (by comparison) conscious Dinner, the same responder to the same Toast told his brother Glaswegians that he had been sorry to learn when the City, of which he was a Bailie, required a large quantity of 12-in. cast-iron drain pipes (real pipes this time) that they could not be obtained anywhere in Scotland, and the Corporation had had to place their order with an English firm some two hundred or more miles away. The speaker was on the immediate right of the Chairman. Such is fame that the speaker did not know that the Chairman was the only man in Scotland who did make 12-in. pipes! Which reminds one of the Hottentot proverb: "No man is a profit maker in his own Country."

* * *

A friend asked the other day what was all this pother between some champions of welding and some devotees of founding. "Do not founders (said he) practice welding on their castings?" "And (said I) do not welders practice on the public?"

MARKSMAN.

American Steel Industry.

Orders for commercial-steel castings in October totalled 11,853 tons, or 8.1 per cent. of the capacity of the 130 plants reporting to the Department of Commerce, against 11,883 tons in September with the same rate of operations. Production rose 1,143 tons to 12,480 tons from 11,337 tons.

Orders in the first 10 months of 1932 totalled 131,039 tons compared with 352,795 tons in the corresponding period of last year, and production aggregated 150,063 tons against 392,049 tons.

The Single-Cast Piston Ring in Green-Sand Moulds.

By Colin Duncombe Abell.

On making comparative cost accounts of crucible and cupola melting the odds are very greatly in favour of the latter method, especially when the full cost of the finished castings are considered. In this particular aspect the "cost per ton of finished piston rings" is very important. Actually, in practice, there is a total advantage on the side of cupola melting of some 60 to 70 per cent., even including the use of additions of nickel and chromium when required.

The following notes embody some particulars with regard to the mass production of piston-ring castings in green-sand moulds by the "multiple-mould process."

Piston rings are produced from castings of two types, viz.:—(*a*) Pots, which are similar to short pipes, with a certain type of flange at one end only to facilitate machining, the flange being held in the jaws of the chuck and the rings machined off by means of stepped parting tools arranged to fit on to the traverse of the lathe; and (*b*) single castings, each of which is one piston ring, with its attendant runner and riser. As regards the manner of melting the metal, they may be made in the ordinary way by casting the pots with cupola metal (often adopted for this type), or centrifugally with cupola or crucible metal (recently-developed process), whilst single-cast piston rings are usually cast with crucible-melted metal, though the writer doubts very strongly the necessity for this, especially in view of the cost, provided certain precautions are adopted. Roughly speaking, the cost of production of the castings, considered as cost of operations in the foundry, is 30s. in the case of crucible-melted metal and about 18s. in the case of cupola-melted metal. These figures do not include the cost of the pig-iron used nor that of the scrap. The usual price of the pig-iron used in crucible work for this type of work is from 100s. to 140s. per ton, the scrap including wasters and foundry pig from the cupola.

Pot-ring castings are classed as small and large pots. Single-cast piston rings do not usually exceed 5 in. in dia., though larger ones have been made quite satisfactorily. In this case, however, it is not economical to produce much larger rings, as the work entailed in the moulding processes rises out of proportion to the output of the ring castings.

Pattern Plates.

The method of moulding and casting is interesting and to a certain extent ingenious; the method here shown is an improvement upon one which the writer has seen where the runners are bifurcated almost at right angles. The method

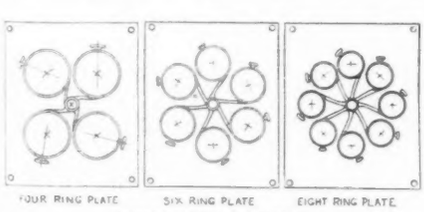

FIG. 1.—PATTERN PLATE ARRANGEMENTS FOR SINGLE-CAST PISTON RINGS.

shown is much better and allows of more definite control and of certainty in filling the moulds completely, flatness of the rings and freedom from sand inclusions. The sand inclusions were generally, but not always, found near the ingate and riser using the more tortuous form of runner. The pattern plates are single and can be designed for use on any type of plain pneumatic or magnetic moulding machines. The flasks (Fig. 2), which are about 1½ in. deep, are plain iron castings carrying small lugs on the inner edge of the underside which locate against the inside of the flask preceding, so forming

FIG. 2.—TYPE OF MOULDING BOX USED FOR SINGLE-CAST RINGS.

the drag for the one above, which is thus similar in every respect. Each flask forms the cope for the one preceding it until a mould or "stack" of from 8 to 12 flasks have been superimposed upon one another to form one continuous mould. The major runner is called the "stalk," from which run the minor runners or "branches" to the ingates. The reason for having a series of flasks thus placed is twofold: (*a*) to obtain a composite mould which may be poured as one and (*b*) the weight of the superimposed copes prevents undue distortion of the castings during the cooling down, a phenomenon very likely to occur owing to the thin sections of the castings. The plates are usually designed to carry 4, 6 or 8 ring patterns complete with runners, risers and master runner or "stalk" as shown in Fig. 3.

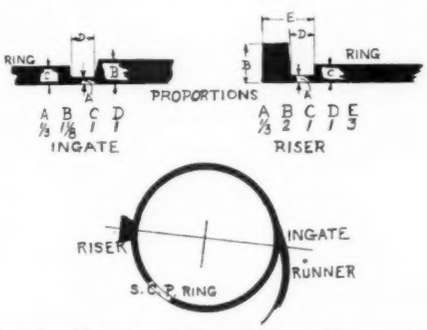

FIG. 3.—METHODS OF RUNNING AND PROPORTIONS USED THEREFORE.

From a practical point of view in the foundry, the incidence of the tangential runners and ingates is vastly superior to that of the bifurcated runners entering radially into the mould of a type which the writer has seen used and which suffered rather badly from short-runs and chilling, primarily because the stream of metal was divided into two parts before reaching the ingates to two adjacent rings and then suffered a further diversion upon entering the ring-mould proper. The trouble was first ascribed to a peculiar accumulative effect of the melting, but since the mixtures contained very small proportions of scrap this was obviously extremely unlikely. The whole secret of the cause of the trouble lies in the mould, as will be demonstrated quite easily by the data below.

The method here shown produces an uninterrupted path for the molten metal, which is at the same time shorter than that obtained with the old pattern plate, and, moreover, by preventing the impact of molten metal against the sand faces of the mould prevents the incidental trouble of sand inclusions.

Thermal Considerations of the Mould.

The iron is melted in a 350-lb. Morgan oil-fired crucible furnace having a low-pressure burner and temperatures of from 1,320 deg. C. to 1,400 deg. C. are obtainable quite easily, and if care is adopted they may rise to 1,460 deg. C. Usually about 4½ to 4¾ galls. of fuel oil (60 secs.) to 300 to 320 lbs. of iron are required and a melt takes about 2 hrs. to reach a suitable casting temperature. The metal is tapped into small ladles of the requisite capacity for one or more moulds, preferably one at a time in order to ensure regularity in the temperature. Cupola metal may be used for the moulds, and that is a good reason for developing a better type of mould, apart from the fact that much hotter metal may be obtained from the cupola, viz., 1,460 deg. C. to 1,560 deg. C. The solidification point of the metal is about 1,100 deg. C. to 1,150 deg C., and for crucible metal this gives an approximate cooling range of 220 deg. C. before solidification takes place. It is instructive to illustrate the effect of the mould as follows:—Assume two cross-sections of unit length of the circumference of the ring, viz., ¼ by ¼ by 1 in. and ⅛ by ⅛ by 1 in. Then the area of the cross-sections are $\frac{1}{16}$ and $\frac{1}{64}$ sq. in. respectively, and the volumes are $\frac{1}{16}$ and $\frac{1}{64}$ cub. in. respectively. Grey cast iron weighs 0.261 lbs. per cub. in. approximately, so that the weights of these unit sections are 0.1631 and 0.0408 lbs. The total heat of cast iron, as shown in Fig. 4, at the temperatures given above for

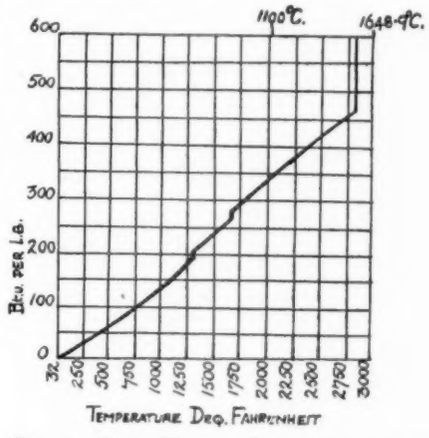

FIG. 4.—TOTAL HEAT OF IRON AVAILABLE AT VARIOUS TEMPERATURES.

crucible metal is about 400 B.T.U. per lb. (at 1,320 deg. C., hence the amounts of heat contained in these unit sections of metal at 1,320 deg. C.) are 65.24 and 16.32 B.T.U. respectively. The effective chilling which will render these rings unmachinable must be dependent upon the capacity of the mould to abstract this heat and also the rate at which it does this. Summarising, one has the following, viz.:—

Section	¼ × ¼ × 1 in.	¼ × ¼ × 1 in.
Heat content	65.24 B.T.U.	16.32 B.T.U.
Weight	0.1631 lbs.	0.0408 lbs.
Temperature	1,320 deg. C.	1,320 deg. C.

Allowing for a drop of 50 deg. F., from the ladle to the runner this gives for the two sections a loss of 1.631 and 0.41 B.T.U. respectively, leaving 63.61 and 15.91 B.T.U. in each case, at a temperature of 2,358 deg. F. The heat lost down to the solidification point is then 11.42 and 2.86 B.T.U. in each case, leaving 52.19 and 13.05 B.T.U. respectively. The latent heat of fusion of grey cast iron is about 130 B.T.U. per lb. and in these cases this gives 21.20 and 5.30 B.T.U. respectively at 2,012 deg. F., leaving 30.99 and 7.75 B.T.U. as the heat which is abstracted from the metal from the solidification point down to the ordinary temperatures.

The total loss operative down to, and at, 2,012 deg. F. in each case is 32.63 and 8.16 B.T.U.,

and is that heat which, if, as is certain in this case, is abstracted quickly by the mould, determines the extent of the chilling. The approximate heat capacity of dry sand at 1,000 deg. C. (1,832 deg. F.) is only 1.23 B.T.U. per lb., so that the sand alone is not the most important factor in chilling. In green-sand moulds for fine work of this description there is a varying moisture content of 1.5 to 2.8 per cent., and in order to vaporise 1 lb. of water at and from 212 deg. F. it requires 970 B.T.U. per lb. When one sees that the main effect in green-sand work for single-cast piston rings is due to the moisture content which should be kept as low as possible, all other factors being considered. Since the moulds do not have to withstand any great pressure as there are no cores in the true sense this is not a very serious drawback.

The circumferential distance which has to be traversed by the molten iron is determined by the diameter of the rings. Hence, considering different effective volumes of moist sand around the ring sections taken above from 1-in. by 1-in. to 2-in. by 2-in. cross-section, the length of the sand unit is as follows, viz.:—

Section ..	1 × 1 in.	1.5 × 1.5 in.	2.0 × 2.0 in.
1 lb. sand ..	15.8 in.	7.05 in.	3.95 in.

and obviously, *provided the moisture content is kept low*, the effective volume of sand has a cross-section under 1 in. by 1in. The greater the moisture content, the greater is the effective chilling as it is tantamount to increasing the effective volume of the sand.

For the small sections considered above the effective volume of sand extends only about ¼-in. by ¼-in. to ⅜-in. by ⅜-in. cross-section in actual practice, with a low-moisture content and due to the low-heat capacity of sand. Naturally, of course, the mechanics of the flow of the molten metal in the mould play a very important part in this respect and the writer hopes to give a *résumé* of this question in the near future if time permits.

It is from these and other considerations of the thermodynamics of these moulds that the dimensions are calculated and strict adherance must be kept if satisfactory green-sand work is expected.

Metallography.

In this type of work the question of the range over which chilling is effective is of paramount importance in that the extent to which the molten iron is chilled without solidification and the rate of this cooling upon first entering the mould and also the subsequent rate of dissipation of heat, dependent upon the mass of the ring, are the factors determining whether the iron will contain a large amount of cementite and also the morphological orientation, especially in the areas of the phosphide eutectic.

In castings of this type where there are very thin sections the graphite formed is almost wholly primary and very little evidence is found of the decomposition of the small amounts of pearlite present. The iron is almost a technically-perfect example of a super-cooled hypo-eutectic structure showing arrested development of the pearlite from austenite.

Fig. 5.—Showing Inherent Strain in Pot Rings.

A single-cast piston ring when fractured anywhere on the periphery will not spring apart owing to the presence of contraction strains, whereas pot-piston rings show a gap of from ¼ in. to ⅜ in., according to the size of the ring, as shown in Fig. 5. Single-cast piston rings are given a heat-treatment on a mandrel after the preliminary machining; the mandrel springs them apart to a certain predetermined extent at the scarve and the effect of the process is to give them a permanent set in this position, so that they thus require quite considerable pressure to close them to a perfect circle. It is simply an annealing process to remove strains due to contraction in the mould, and is carried out in a salt bath (3 to 5 per cent. NaCN) at 380 to 450 deg. C., in a furnace of the Brayshaw case-hardening type; this is followed by a quench in water, which also dissolves away the salts. The loss in strength due to the annealing is to a large extent regained by the quenching.

As cast, a single-cast ring when pulled alternately in opposite directions longitudinally as if it were a spring will return to the normal position when the stress is removed, whilst pot rings do not so return and show a certain deformation. Nevertheless, when heat-treated in this way, single-cast rings do not possess a much greater strength than good pot rings, and may have a lower tensile strength than the latter. The superiority of single-cast piston rings is due entirely to the much smaller amount of secondary graphite, although a small amount is produced by the heat-treatment process, especially in and around the phosphide areas.

Single-cast rings have in general a higher Rockwell hardness than pot rings owing to the preponderance of cementite. Pot-piston rings are always inherently pearlitic under the conditions of manufacture to-day, whilst single-cast piston rings are invariably cementitic with a coarse phosphide network, even the largest rings made this way containing a high proportion of cementite, as would be expected from a cursory observation of the conditions. The structure of single-cast piston rings is typical and shows large isolated areas of cementite in the massive and laminated condition, pot-piston rings contain a higher proportion of ferrite, and the cementite, other than that in the pearlite, is confined to the fine-phosphide network.

Suitable analyses are shown in Table I:—

	T.C.	Si.	S.	P.	Mn.	Ni.
Large single-cast rings	3.35	3.0	0.03	0.6	0.86	0.60 per cent.
Small single-cast rings	3.40	3.2	0.03	0.7	0.86	0.60 „
Large pot rings	3.30	1.6	0.12	0.5	0.90	nil „
Small pot rings	3.40	1.8	0.09	0.7	0.75	nil „

N.B.—Alternatively: T.C. 3.3; Si 1.8; S 0.09; P 0.6; Mn 0.8; Cr 0.20 per cent.

Alloy Additions Recommended.

In all these analyses a definite increase in the mean hardness and toughness of the rings may be obtained by increasing the manganese and decreasing the sulphur without causing any increase in the cementite, and at the same time increasing the resistance to distortion and fracture at elevated temperatures. In any case, with small single-cast rings, the nickel should be much higher at 1.3 per cent. in order to obtain a technical pearlitic iron, though, unfortunately, most of these castings are made with crucible metal which severely limits the application of alloy additions to this class of work. There is no reason, however, against cupola metal being used for single-cast rings if a silicon of about 2.80 per cent. and nickel about 1.6 to 1.8 per cent. are adopted; in this case the manganese should not exceed 0.60 per cent. Pot-piston rings for high-duty work, as in Diesel engines for marine work and for aircraft, should contain not less than 0.80 per cent. manganese and not more than 0.20 per cent. chromium, as indicated in the alternative analysis above.

Mr. Arthur Docking, who was formerly associated with Premix Gas Plants, Limited, has founded the firm of Arthur Docking & Company, Radiant Works, Johnson Street, London, S.W.1, for the carrying out of industrial heating work in association with Messrs. Crossley Bros., Limited, of Openshaw, Manchester.

Reduction of Iron Oxides by Carbon and Potassium Cyanide.

In Report No. 133 of the Blast-Furnace Committee of the Association of German Ironmasters, published in a recent issue of "Archiv für das Eisenhüttenwesen," F. Körber and H. H. Meyer discuss the reduction of iron oxides at high temperatures in relation to the question of blast-furnace explosions. If the burden hangs, very large quantities of carbon are deposited in the ore from the rising carbon monoxide, which are suddenly brought into the high-temperature zone when slipping occurs. On account of the intimate mixture with the finely-divided carbon, the possibility must be reckoned with that the ore will be reduced with some vehemence with the release of large quantities of gas in a very short period. Similar results may be expected if large quantities of cyanide accumulate and then suddenly descend. A series of tests was carried out on the reduction of iron oxides to ascertain whether the gases evolved reached amounts which would constitute a danger to the furnace.

The ores used in the tests were a porous siliceous minette with 41.5 per cent. Fe, a compact hematite ore with 57.6 per cent. Fe, and a manganiferous ore with 24.6 per cent. Fe and 34.6 per cent. Mn. The reduction by carbon was effected by means of coke, charcoal and carbon deposited from carbon monoxide. The coke, or charcoal, and ore were crushed to less than 0.13 mm. in size and intimately mixed, while for the reduction tests with deposited carbon the ore, crushed to 2 to 4.5 mm., was subjected to a stream of carbon monoxide at a temperature of 500 to 600 deg. C. The reduction tests were carried out at various temperatures between 1,000 and 1,400 deg. C., the rate of gas evolution and extent of reduction being determined.

Experiments were also made on the reduction of ferric oxide and of the above three ores by potassium cyanide. In the case of the manganiferous ore, the manganous oxide was only reduced very slowly by cyanide, no reduction of this oxide being effected by carbon at temperatures under 1,300 deg. C.

Comparing the results of the reduction of iron oxide by carbon and by potassium cyanide, it was shown that, while violent reduction by carbon first began between 1,000 and 1,100 deg. C., this occurred with cyanide at 800 to 900 deg. C. Potassium cyanide reduced powdered ferric oxide, lump minette and also hematite (with excess of ore) at the same rate since the vaporised or liquid cyanide readily penetrated the ore. The reduction times for the evolution of 100 cub. cm. of gas from 1 grm. of Fe_2O_3 were approximately 30, 18 and 28 secs. for powdered ferric oxide, minette and hematite respectively at 900 deg. C., 17 secs. for all three at 1,000 deg. C. and 6 secs. at 1,300 deg. C. The speed of reduction of the minette by deposited carbon is only about half that by cyanide. Reduction of pure ferric oxide by charcoal is appreciably slower than that of minette by deposited carbon at 1,000 and 1,100 deg. C. (at the latter temperature approximately 46 and 23 secs. respectively for 100 cub. cm.); at 1,200 deg. C., however, the reduction takes place at the same rate for both (about 16 secs. for 100 cub. cm.). Deposited carbon reduces hematite appreciably more slowly than minette, the times for the evolution of 100 cub. cm. of gas being about doubled.

(*Concluded on page* 398.)

Some Aspects of the Selection of Engineering Materials.

By L. B. Hunt, A.R.C.S., M.Sc.

(*Concluded from page* 385.)

Phosphorus in Cast Iron.

There are also certain undesirable constituents which are found in this structural state. In the case of aluminium alloys, the most important impurity is iron in the form of $FeAl_3$, but here engineers have been fortunate in having the results of Gwyer and Phillips, and of Stockdale and Wilkinson to go upon. The case of phosphorus in cast iron, existing as a eutectic of iron and iron phosphide, is, on the other hand, shrouded in obscurity. Whilst aluminium alloys are a product of the laboratory, cast iron is a heritage from antiquity, which has only recently come under scientific control, and as a consequence of this, and of its greater complexity of structure, there are no similar reliable data on the effects of impurities on the properties of cast iron. It is clear, however, that a constituent such as this phosphide eutectic, in which slip does not occur to any appreciable extent, if at all, should be restricted to the absolute minimum in the modern type of high-duty cast irons, in which appreciable deformation is possible.

A further type of second constituent is represented by the various non-metallic impurities, including oxides, slag inclusions, and special cases such as graphite in cast iron. The essential difference to be observed here is that the cohesive forces operative between metallic matrix and non-metallic impurities are by no means the same as with a second metallic constituent. These bodies may act as centres of high local stress owing to their differing properties and power of deformation, and may thus serve to reduce the resistance to repeated stress to a considerable degree, although having small effect on static test results.

Basis for the Selection of Materials.

The most rational basis for the selection of materials to withstand appreciable stresses is thus to get as clear an idea as possible, first of the mechanism of failure likely to occur, and then of the effects of variations in composition and structure of the available material on this mechanism. This can then be followed by the drawing up of a specification covering these variations by means of limits for chemical analysis and mechanical tests, provided that the tests are chosen to give some indication of the likelihood of failure in service, and also bear some relation to the type of structure and constitution of the material. For example, in the case of cast iron, the properties are governed on the one hand by the nature of the metallic matrix, and on the other hand by the amount and distribution of the graphite and phosphide constituents, and tests must be chosen to indicate as far as possible the part played by each. In this connection it would appear that the numerous attempts to correlate Brinell hardness and tensile strength, in the same way as for steel, have little chance of success, since the Brinell test—essentially a compression test—is dependent almost entirely on the hardness of the crystalline matrix, whilst tensile failure is largely influenced by the graphite distribution.

Having decided upon the tests to be applied, however, the problem becomes one of correlating the results of these tests and of other methods of examination with the mechanism of deformation and rupture. It may be said at once that mechanical properties alone are not a sufficient guide to the suitability of a material for use in automobile engineering, and cannot be considered apart from the composition and structure of an alloy, as revealed by chemical analysis and microstructure. These three broad methods of examination and acceptance will therefore be considered in relation to the information they yield about the stress resisting properties of engineering materials.

Function of Chemical Analysis.

The primary purpose of chemical analysis, at least as far as the main constituents of an alloy are concerned, might be described as a means of reference to the equilibrium diagram, although, of course, equilibrium conditions are by no means always met with. The equilibrium diagram, however, must be the starting point, either consciously or unconsciously, in the assessment of an alloy and its value in a given set of conditions. It represents a complete graphical summary of knowledge of the composition of the various constituents, and their relative proportions, and in this way may be considered as a means of translating an ordinary chemical analysis into something resembling the type of rational analysis employed for such materials as refractories, provided, of course, that something is known of the cooling conditions of the alloy. In short, chemical analysis is valuable only in so far as it forms a guide to the structure of an alloy, and thus to the manner in which resistance to slip has been obtained. The chemical composition given on a specification may thus be regarded as a statement of the manner in which slip is to be obstructed in order to obtain the required mechanical properties. In the writer's opinion the suggestion that chemical composition should not be included in specifications cannot be upheld on logical grounds. The first choice of an alloy for a particular duty implies a certain approximate composition, and it is only reasonable to state this desired composition in black and white in the specification.

A great proportion of the chemical analyses carried out, however, are for the purpose of keeping check on undesirable impurities, and generally constitute the only method of doing so. Here, again, the structural viewpoint must be adopted. A deleterious element may exist in the form of a compound, or as a eutectic, and may thus give rise to an undesirable constituent many times greater in amount than the apparent quantity of impurity present. To refer again to phosphorus in cast iron, this is known to exist as a hard and brittle eutectic of iron and iron phosphide, containing only about 10 per cent. of phosphorus. Therefore an iron containing 0.5 per cent. of phosphorus by analysis will contain approximately 5 per cent. of the phosphide eutectic. The restriction of such constituents to the absolute minimum possible has the effect of reducing the susceptibility to stress concentration effects without materially reducing the desirable resistance to slip. This raises the question of the primary resistance to stress concentration characteristic of the pure metal or alloy, and its consequent employment as an engineering material. It is sometimes argued, for instance, that as cast iron is in any case a poor subject owing to the stress-concentration effects due to the presence of graphite, which, after all, constitutes its main point of difference from steel, a certain additional amount of so-called "stress-raisers" will not do much harm. However, with the present tendency to a reduction in the amount and size of the graphite flakes, the author cannot agree that this view is sound, and prefers an iron containing less than 0.30 per cent. phosphorus for all castings required to withstand appreciable stresses.

Correlation with Microstructure.

The rational analysis obtained by inference from the chemical analysis and the equilibrium diagram may then be correlated with the microstructure, which is more informative on such points as grain size and shape, distribution of brittle constituents, and also indicates any departure from equilibrium conditions. The inclusion of microstructure in a specification, however, raises considerable difficulties, which were emphasised in the discussion on the report recently submitted by the Malleable Iron Sub-Committee of the Institute of British Foundrymen. One criticism put forward was that founders of both grey and malleable iron might soon be compelled to make to a structure as well as to mechanical tests. Now the makers of high-duty cast iron are quite definitely working to microstructure at present, with general satisfaction to themselves and to the users of this material, although no mention of this is made, or can conveniently be made, in a specification. This, of course, is a case where the imaginary "income-tax collector" engineer would be at a loss, but where collaboration between engineering metallurgist and manufacturing metallurgist will achieve success. In a specification such as for steel, which includes heat-treatment operations, the microstructure produced by these operations is naturally at the back of one's mind in drawing up the specification, and considerations of microstructure cannot possibly be omitted from the evidence in selecting the most suitable material.

The Significance of Mechanical Tests.

The value and meaning to be attached to the relatively simple and rapid mechanical tests which are applied to obtain some idea of the probable behaviour and durability of a material in complex service conditions are of real interest. On the basis which has been outlined these tests should, wherever possible, be directed towards the evaluation of the comparative difficulty with which slip is initiated and propagated, and of the capacity for slip without rupture. In other words, tests and test results should be judged by the amount of indication they give of the likelihood of failure by deformation and rupture, and not necessarily by their relation to some particular service requirement. It is clear that engineers must always be content with a compromise. The amount to which slip can be hindered by the reduction of the smoothness and extent of the slip planes is definitely limited by the requisite amount of slip to provide the resistance to stress concentration effects and crack formation. The essential nature of this compromise has been brought out by the investigations on the mechanism of fatigue which have been mentioned earlier in the Paper, and can also be appreciated from the tempering temperature curves for an alloy steel, a type of material which undergoes the strictest supervision of any.

Value of Elongation Figure.

Viewed in this light, the tensile test appears still to be the most reliable guide, taken as a single test, to the fundamental properties of a metal, despite the criticism to which it has been subjected on the grounds that materials are seldom employed in direct tension. This absence of similarity of stressing in testing and in service is not necessarily to be regarded as detrimental to the test as a source of information. The elastic limit, if it can be measured, gives an indication of the stress at which slip commences, whilst the ultimate stress may be considered as the plastic limit, or the stress corresponding to the limit of slip before actual separation occurs. The engineer's requirements of his materials have been expressed as stability and long life. The elastic limit is naturally a measure of stability under steady load, whilst the fatigue limit is required to give an idea of

long life. By reference to the mechanism of rupture previously described, it can be seen that the plastic limit or maximum stress should normally bear a relation to the fatigue limit. In the one case, slip is continued until cohesion is exceeded locally, and in the other, a small amount of slip repeated many times serves to produce the same effect very gradually. Elongation as measured in the tensile test gives a measure of the amount of slip possible before rupture takes place, when under axial stresses; and as such is a vital condition of the suitability of a material. This rather obvious point is emphasised, as a number of engineers and metallurgists have scoffed at the demand for a minimum percentage elongation in a specification, when a very small fraction of that elongation, if it took place in service, would entirely ruin the structure. The elongation requirement is, of course, a form of insurance against total collapse under local stresses exceeding the elastic limit, and as such is a most necessary condition, whatever the form of loading in service.

Notched Bar Test.

The same remarks apply to reduction of area, which is usually a more sensitive guide to this form of ductility. Neither of these properties, however, tells the whole story of susceptibility to high local stresses, primarily due to their reference to purely tensile stress, and the notched-bar test is necessary in order to obtain further information. This test is admittedly of a complex nature, and requires very careful interpretation. There has been a tendency in the past to regard the notched-bar test merely as a shock test. This is a gross misconception of the test and its usefulness, although resistance to shock is, of course, one of the properties measured by the test. The same results can be obtained with this test if the specimen is bent slowly; the form of loading by impact is merely a convenient manner of obtaining information as to the effect of a notch on the susceptibility to rupture. The root of the notch is a region of high local stress, whilst the surrounding metal tends to stiffen the specimen. The result is something approaching a state of three-dimensional tension. If, then, the resistance to slip is large compared with the cohesion, the latter may be overcome before the shear stresses have exceeded the slip resistance, and failure will occur by rupture without deformation, giving a low figure for the energy absorbed. If, however, local slip can occur, the high local stresses will tend to be redistributed, and much more energy will be required for rupture.

Thus, too high a resistance to slip, as evidenced by a high elastic limit, is undesirable in a material required to resist stress concentration arising from change of section or similar causes. This sensitiveness to stress concentration, which is appreciable in the case of aluminium-casting alloys, and more pronounced with magnesium alloys, would suggest from first principles the institution of a notched-bar test, similar to that employed for wrought steels but of a less severe nature. Dr. Rosenhain has recently suggested the use of a transverse test similar to that employed for cast iron, for the aluminium-casting alloys, as the measurement of small amounts of elongation in the tensile test is very difficult. This suggestion is based on the very real necessity to obtain the most accurate information on the small amount of slip possible in this type of material, in order to ensure against premature failure by stress concentration effects.

The Case of Cast Iron.

In the case of cast iron the notch has little or no effect on the result of the test, and this fact has been used to condemn the test out of hand. A little reflection, however, shows that a piece of cast iron already contains many thousands of seats of high local stress due to the presence of graphite, and that a notch would serve no real purpose. Using unnotched bars in an Izod machine, however, it is possible to obtain a certain amount of data on the relative merits of cast irons. The results obtained naturally bear some relation to those for deflection in the transverse test, but may give a more pronounced indication of an improvement in structure and of resistance to shock.

The Stanton repeated-impact test employed for cast iron is of a still more complex nature than the single-blow type of test, and depends to a great extent on the variations in the weight of the hammer and the height of fall—that is, on the number of blows required for failure to occur. With a heavy tup and consequently a small number of blows to fracture, the test bears a relation to the single-blow test, but when the number of blows runs into thousands, results are obtained which resemble those from a fatigue test. Owing to the virtual absence of deformation in this test, the mechanism is one of crack propagation against the cohesion of the metal, and the results bear a relation to those for tensile strength and fatigue limit. A combination of the tensile test and a single-blow notched-bar test is probably a more reliable guide to the fundamental properties of a material.

Fatigue Testing.

It is not possible to say very much about fatigue testing in a Paper of this kind. Fatigue tests are still without a place in specifications, and one is usually left to infer the resistance to repeated stresses from the results of short-time tests. This is a comparatively simple matter in the case of wrought steels, where the fatigue limit has been found to bear a simple relation to the ultimate stress, but in non-ferrous metals no such relation has as yet been discovered, even if it exists at all. It has been estimated, however, that over 90 per cent. of the failures in automobile parts are due to fatigue, that is, to a spreading crack following slight but repeated slip in a crystalline grain. Engineers are thus in a position of knowing the cause of failure in their materials, but not being able to guard against this failure by means of specification requirements, but of having to use large factors of safety. It will be clear from what has been said of the mechanism of failure that these factors of safety are nothing much more than the allowances shown to be necessary by experience for the effects of stress concentration and repetition. From what has been said of the mechanism of failure by fatigue, it is clear that the requirements of a material must be the maximum resistance to the commencement of slip commensurate with the minimum capacity for slip to allow of the redistribution of localised stresses. In other words, slip resistance and cohesion must both be as high as possible, subject to the latter always exceeding the former by an amount sufficient to prevent rapid crack formation.

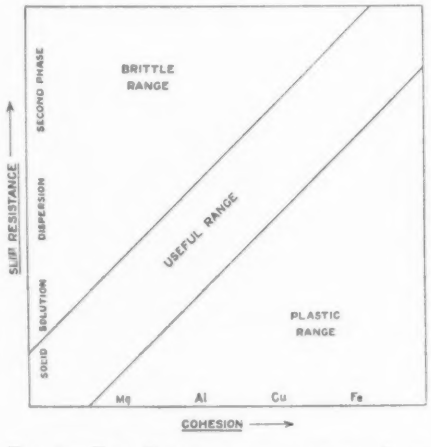

Fig. 1.—The Relationship between Slip-Resistance and Cohesion for Various Metals.

This relationship is represented diagrammatically in Fig. 1, from which it can be seen that, as the cohesive properties of the metals increase, resistance to slip may also be increased. If slip resistance is not sufficiently pronounced, however, the alloy will be unduly soft and plastic, whilst if slip resistance becomes too great relative to cohesion, brittleness will result. This scheme is intended only as a rough guide to the possibilities of individual alloys, and is not, of course, to be regarded as a survey of their actual properties.

In selecting a material for a particular duty, there are many other variations to be taken into consideration, but the present Paper is intended to give an outline of the problem. Special properties can, as a rule, receive consideration only after the general stress-resisting properties have been settled upon, and the case has been oversimplified in order to give a connected account of the application of fundamental research to the practical problems of engineering metallurgy.

The mental picture which has been drawn of the deformation and rupture of metals is not a model to be followed blindly, but is used with discretion, is of undoubted value in sorting out the things that matter from those that do not, and in visualising the necessary properties for service conditions. It is not yet possible to give numerical values to fundamental properties, but it is essential to state them in such a way as to render them readily conceivable in an exact manner. Precision of testing is not synonymous with significance, and intimate knowledge and research are necessary to appreciate fully the sphere of usefulness of the many metals and alloys available.

In conclusion, the author quoted some words of Dr. Rosenhain from an address given by him to the International Association for Testing Materials:—"Every step we can take in the direction of a fuller understanding of the internal mechanism of metals is, therefore, a step forward in the testing and use of metals as engineering materials."

Reduction of Iron Oxides by Carbon and Potassium Cyanide.

(*Concluded from page* 396.)

It is possible to form an opinion about the danger of a rise in pressure in a blast furnace caused by the sudden evolution of gas by comparing the volume of gas evolved in a unit of time with the volume of blast supplied to the furnace in the same period under normal working conditions. In the case of an 800-ton furnace (on the assumption of 25 per cent. of deposited carbon and similarly rapid heating to 1,300 deg. C., as in the laboratory experiments), when a slip occurs in the blast furnace, a fall of only 5 to 6 tons of minette would give an evolution of gas equivalent to the volume of blast, *i.e.*, could result in the pressure in the furnace being doubled. Following a heavy scaffolding, a fall of 50 cub. m. is possible in a furnace of this size, or on the basis of 40 per cent. ore, say about 40 tons of ore and even more. The gas evolved by such a fall could give rise to a sudden increase in pressure to six to seven times the normal. Similar considerations show that the descent of large quantities of potassium cyanide can cause very considerable additional stresses in the furnace, due to the reduction of the ore. Apart from this, however, the sudden vaporising of the cyanide produces a volume equal to two-thirds of the total volume of gas evolved by reduction. One ton of potassium cyanide, which is a possible amount to fall, occupies in the gaseous state 10½ times the volume of the blast per sec. Since the evaporation takes places in a few secs., the sudden production of the vapour may occasion a considerable increase in the pressure in the furnace.

Some Experiences with the Balanced Blast Cupola.*

By H. H. Shepherd.

Introduction.

This Paper is really the subject of a report which the author was called upon to prepare for the directors of his company. It relates to his experiences with two "balanced-blast" cupolas, one of which has been in operation in his malleable foundry since March 30, 1932, and the other having been in operation in his grey-iron foundry since May 17, 1932.

Prior to the installation of this system, he had been closely studying the development of the balanced-blast cupola from its inception early in 1930. As is well known, it was designed by the Association's consultant, Mr. J. E. Fletcher. The British and foreign patent rights are the property of the British Cast Iron Research Association.

At the time of drafting this Paper there were 22 cupolas operating this system in England, the sizes varying from 24 in. to 54 in. in diameter inside the lining, and having rated melting capacities of 2.3 to 11.9 tons per hr., the actual melting rates being, in most cases, more than these figures. Cupolas having internal diameters up to 90 in. and giving melting rates of 33 tons per hr., can be built or converted to the balanced-blast type.

The two cupolas which Messrs. Crane, Limited, had converted were originally built to a well-known and widely-advertised foreign design. It is of interest to note that its malleable cupola was the first one engaged in manufacturing malleable castings to be converted to Fletcher's system of balanced blast.

Theory of the System.

It is well known that up to recent years the considered objective in securing an efficient cupola practice was to burn the maximum amount of the carbon content of the coke charges to carbon dioxide (CO_2) at a level very close to the tuyeres, that is, in a localised melting zone. The formation of any quantity of the intermediate gas, carbon monoxide (CO) was regarded as detrimental, and every endeavour was made to minimise the formation of CO and to prevent the escape of any formed by admitting auxiliary air supplies at varying planes in the cupola.

The Stewart cupola, which had two or more rows of tuyeres, and which is still in very common use, was among the first attempts to prevent the escape of unconverted CO, while the Greiner and Erpf cupola, devised about 1860, with its auxiliary tuyeres arranged in spirals, was another effort in this direction. These early improvements in cupola practice were based on the fact that in order to secure the maximum heat value from coke, it is necessary to convert its carbon completely to carbon dioxide (CO_2). The following figures show that this is so, and it will be noted that in the formation of CO only about one-third of the full heat value is obtained:—

Carbon burning to CO_2 gives 8,080 calories or 14,544 B.T.U.

Carbon burning to CO gives 2,473 calories or 4,450 B.T.U.

As is well known, flame at the charging door shows that there is CO escaping, and by admitting air at different levels it was hoped to prevent or reduce this escape. It will be recognised that it requires a greater amount of air (more precisely oxygen) per unit of carbon to form CO_2 than is required for the production of CO. In consequence, the general custom has been to force excessive quantities of air into the cupola in order to minimise CO formation. Incidentally, these excessive amounts of air often led to necessary increases in the amount of coke, so that the problem of a balanced heat supply often became a vicious circle—increasing air to decrease CO and having to increase the coke, in most cases, to use up great excess of air.

Recent Improvements.

Of recent years cupola-practice problems have been given very much more serious scientific attention, and one of the first factors was to secure maximum heat efficiency. It has also been recognised that the use of an excessive quantity of air is not only bad practice but has a deleterious effect upon the iron. It increases considerably the amount of occluded gases, and one could say, with little fear of contradiction, that "gas" in metal is responsible for the greater portion of those difficult scrap-causing problems. Excessive air obviously results in an intense oxidising atmosphere in the cupola, and, in the production of high-quality castings, such as high-strength iron, too much coke or air completely defeats the objective.

The modern method of dealing with this problem has been to cut down the excessive air or oxygen volume by having closer control of the air entering the furnace, that is, securing a closer relationship of the amount of air or oxygen entering in a unit time, to that theoretically required to burn a given amount of coke or carbon, the amount of the latter being again determined by the quantity of heat units required to melt a given amount of iron in a specified time. This closer control led to many considerable improvements in cupola practice. It was, however, left to one or two investigators to realise that the ideal practice would be to carry out the main melting action in a reducing atmosphere, by maintaining an atmosphere of CO in the lower part of the furnace. It will be seen that this is just the reverse of previous practice. To create and maintain such a reducing atmosphere is by no means an easy matter, and, although Poumay had the same principle in mind when he introduced his cupola and system of melting, his practice, in the writer's opinion, leaves much to be desired. Control was very limited; it lacked elasticity; once the auxiliary tuyeres were set to a standard practice it was not an easy matter to alter them to give any definite predetermined effect; while considerable wear of the lining in the region of these tuyeres took place during each melt. Further, there was no available adjustment or control over the main tuyeres.

J. E. Fletcher, who had for some years been working on the theory that a reducing atmosphere was vital to the efficiency of practice and to the production of good, clean iron, free from oxidising gases, says: "I started out with the idea and conviction that the air control should restrict the air supply to the lower part of the coke bed, so as to limit the amount of free air or oxygen of the gases in this zone to the lowest practicable percentage and, at the same time, to maintain the optimum carbon monoxide contained in these gases."

In order to complete the combustion of CO formed just above the lower tuyeres, further rows of auxiliary tuyeres were added to the balanced blast cupola, at heights sufficient to convert coke carbon at these levels to carbon dioxide, when supplied with air. It is the arrangement of these auxiliary tuyeres and the admittance of the correct amount of air through them which is, to a great extent, responsible not only for the superheat contained in the iron but for some of the coke saving. What is obtained in practice is proved in theory, for the heat developed by the burning of CO to CO_2 amounts to 10,220 B.T.U. so that the descending charges of iron, as they come into contact with the heated air coming through the topmost auxiliary tuyeres, begin to melt and pass down through a gradually increasing highly-incandescent coke bed and become superheated in a reducing atmosphere in the lower part of the cupola. Thus the whole of the bed is effective as a melting medium.

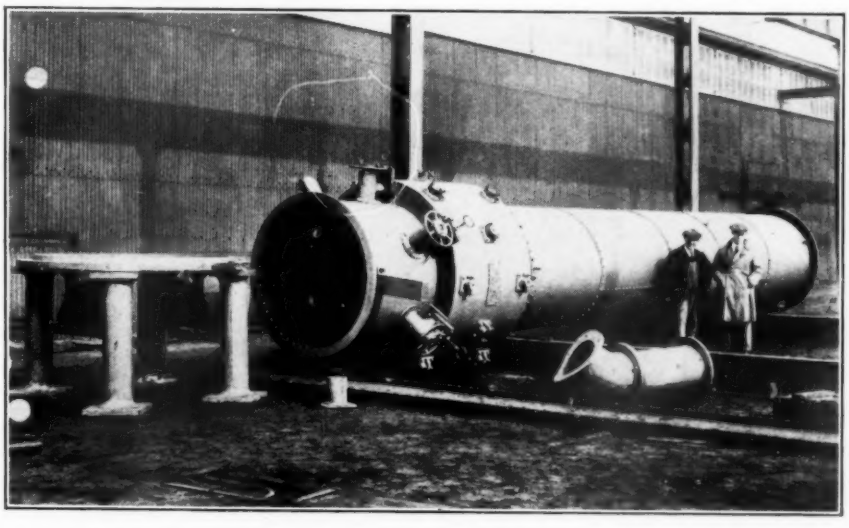

FIG. 1.—A BALANCED BLAST CUPOLA BEFORE ERECTION AT THE WORKS OF CRANES, LIMITED.

Design of the Balanced Blast Cupola.

Fletcher was the first to realise that to secure and maintain a properly balanced atmosphere, such as he required, would necessitate a specially-designed cupola, particularly relating to the tuyeres, for these would all require to be adjustable in order to obtain the correct balance of air between the main and auxiliary tuyeres. As will be seen by Figs. 1 and 2, the balanced blast cupola has a rather deeper wind belt than

* Paper presented to the Birmingham, Coventry and West Midland Branch of the Institute of British Foundrymen, Mr. J. G. Pearce presiding.

most ordinary furnaces. In the case of the malleable cupola installed the wind belt had to be extended considerably because, owing to the limited size of the well or hearth, there was not sufficient room below the belt to insert the main tuyeres, as shown in Fig. 2, so that they had to be fixed through the belt.

The tuyere arrangement consists of a lower row of main tuyeres and valves and two or more rows of small auxiliary tuyeres. The latter are all situated in and fed from the same wind belt. The most important feature of the main tuyeres is that they are controlled by fine adjustable screw valves, which enables the size of the blast inlet of the tuyere to be altered to suit requirements. The handwheels illustrated are attached to a cylinder which can be moved in an horizontal direction and so vary the size of the

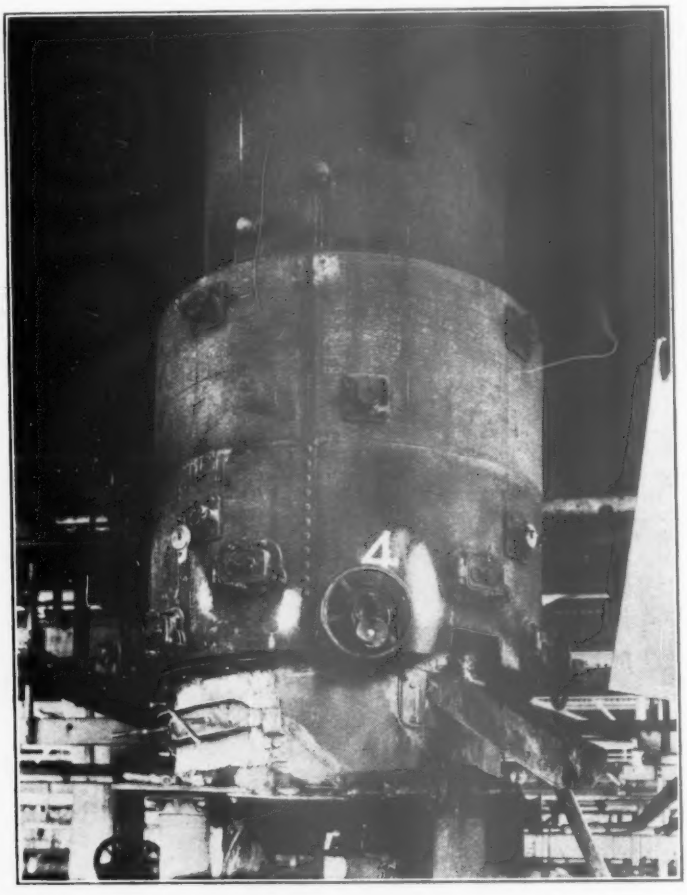

Fig. 2.—Balanced Blast Cupola in the Malleable Foundry of Cranes, Limited.

ports or valve openings. The tuyere apertures between the valves and the cupola lining are designed so that, though the air passing through the valves is at high velocity, the impinging effect on the coke is reduced so as to produce a softer blast. The valve stem is hollow so as to permit inspection and allow for temperature measurements, gas analysis, etc., to be taken if desired. Each tuyere is fitted with an inspection glass, and by means of an ingenious device it is possible to close up the tuyere whilst still being able to observe melting conditions through the inspection glass. Loose outer covers are also fitted to permit cleaning the tuyeres and valve ports. The lining tuyeres to fit the main valves are of Silal heat-resisting cast iron, Silal iron having been developed by the British Cast Iron Research Association.

The auxiliary tuyeres are also adjustable, the principle being somewhat similar to the main tuyeres, except that they do not carry screw valves. The adjustment is made by movement of an inner sleeve over the ports, and once the correct position is obtained the sleeve is kept in position by a set screw. These tuyeres are also fitted with inspection glasses and loose outer covers. The auxiliary lining tuyeres are of varying size steam pipe.

The whole of the above arrangement permits the maximum elasticity of operation and very close control. Herein lies the success of Fletcher's balanced blast cupola, for, despite the many patent inventions and practices from the very inception of cupolas, nobody prior to Fletcher had realised that to deal with an elastic and, very often, erratic melting medium such as the cupola, it was very necessary to equip it with adjustable tuyeres and controls. For a given air supply pressure the throttling of the valves at the main tuyeres results in a slight increase of pressure in the wind belt and, consequently, the passage of more free air through the upper tuyeres; thus a balance of air supply can be maintained between the main tuyeres and the auxiliary ones to suit requirements of working. By reason of correctly-balanced blast conditions, the whole of the cupola area is effective, whereas, in the average ordinary cupola, only the annular space around the lining is effective, the middle being practically ineffective from a melting point of view.

In practice, the balanced blast cupola has shown the advantage of being able to control the air supply over the entire coke bed, and by this means of control the whole of the bed is maintained in an incandescent state at high temperature. That this is so can be easily seen by observing through any of the auxiliary tuyeres a few minutes after blowing. The incandescent bed acts as a thermal storage, and in this way tends to prevent variations in casting temperature of the metal.

Conversion of the Malleable Cupola.

Particulars of alterations to this cupola were given in Drawing No. NWDR. 2616 which was exhibited. It will be noted that it is a 60-in. shell furnace and that the belt had to be extended from 3 ft. to 5 ft. 5 in. in depth. A general view of the furnace after the alterations was shown by Fig. 2. The rectangular tuyere covers do not belong to the balanced blast system, but are those of the previous system. The melting rate required was 6,000 lbs. per hour. This was obtained by reducing the lining or bore diameter to 27 in. for a distance of 7 ft. 3 in. from the top of the well. From a distance of about 1 ft. 4 in. from the top of the belt the lining was tapered off until at a point 2 ft. above this the diameter was opened out to 36 in. This continued up to the charging door.

The tuyere equipment comprises four main valves and tuyeres, three only being required to supply sufficient air to meet the melting rate. One tuyere is kept shut off, but this operation does not apply to one particular tuyere. The tuyeres are marked as shown in Fig. 2a.

At the beginning of the melt, No. 1 is shut off for a definite period of time; it is then opened and No. 2 is shut; this is then opened after the same period of time and No. 3 is shut, and so on, the practice continuing through the whole of the melt. This Fletcher system of tuyere operation is valuable in securing the best melting results, for not only does it result in even melting throughout the whole area, but the periodical shutting off of each tuyere helps to keep the tuyeres clean. The shutting off of the

Fig. 2a.—Showing the Method of Identifying each Tuyere.

tuyeres applies only to the main ones; the auxiliary tuyeres are not altered once the correct tuyere opening size is established. There are three staggered rows of auxiliary tuyeres, and four in each row. The most satisfactory condition of melting on this cupola was obtained when the top row of auxiliary tuyeres was permanently shut off, the remainder being opened to a definite setting. This is the practice at present in operation.

Costs of Conversion.

Table I.—*Cost of Conversion of Malleable Cupola.*

	£	s.	d.
All tuyeres and valves and freightage ..	60	0	0
Air belt extension	3	15	0
Welding rod	0	9	0
Acetylene	2	10	0
Oxygen	1	7	0
Labour (104 man-hours)	10	6	0
Total cost	£78	7	0

(Exclusive of partial re-bricking cost, as this would have to have been done in any case, and of the appropriate extra subscription to the British Cast Iron Research Association.)

The tuyeres and valves are made by a firm who have materially assisted in the development of the cupola, namely, the Horsehay Company, Limited, Horsehay, Wellington, Shropshire. The cost is set out in Table I.

The licence fee, as pointed out, is in the form of an extra subscription to the B.C.I.R.A., and is a single and final payment, depending upon the size of the cupola. The rated output of the cupola is taken as 0.75 tons per sq. ft. of area at the tuyeres. Thus, a 27-in. dia. cupola gives a calculated output of 2.98 tons. The licence fee is proportional to this output.

Operation of the Malleable Balanced-Blast Cupola.

In view of the experience of the British Cast Iron Research Association that the balanced-blast cupola would give material savings in coke required per charge, and also owing to the necessity for operating as economically as possible, it

was decided to open up operations on the balanced-blast cupola with much cheaper coke (so that it is obvious that Mr. Fletcher's job of putting the cupola into operation was made as difficult as possible). The use of cheaper coke had been attempted before, but, owing to the mechanical strength of the particular coke used, the attempt was abandoned. A coke was offered at something like 9s. per ton cheaper than the Welsh coke which had been previously and regularly used, and, although it was mechanically a good one, it had rather a higher percentage of

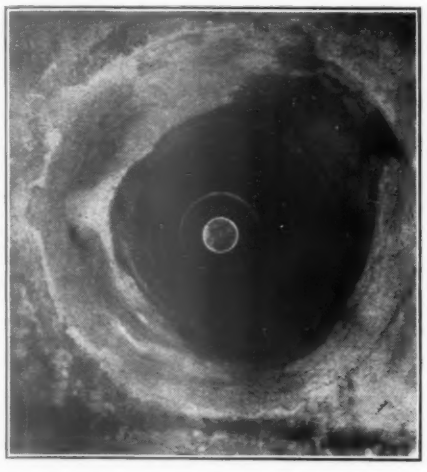

FIG. 3.—SHOWS THE CONDITION OF THE LINING BEFORE USING.

sulphur than the Welsh. It was anticipated that by the use of less coke, possibly the sulphur result could be kept the same as originally. For a period of three months after the conversion of the cupola this cheaper coke was used on its own on all charges, with the exception of the coke bed and the first two melt charges, for which the high-grade Welsh coke was used. The amount of coke used was equivalent to an average melt to coke ratio of 10.4 to 1, exclud-

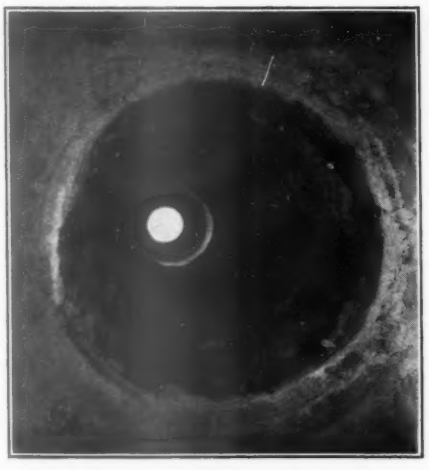

FIG. 4.—SHOWS THE CONDITION OF THE LINING AFTER A 30-TON BLOW.

ing the bed, the amount per metal charge (1,050 lbs.) varying from 100 to 95 lbs., whilst the average coke ratio, including the bed, was 9 to 1. Prior to conversion, for approximately the same weight charge within 10 to 20 lbs., the figures for coke per charge were 130 to 135 lbs. The average coke ratio, excluding the bed was 7.7 to 1, and the average coke ratio including the bed 7.1 to 1.

The above figures were obtained by dividing the actual amount of coke used, excluding and including the bed coke respectively, into the total amounts of metal melted, the average melt per day being 30 tons of 2,000 lbs. If 135 to 130 lbs. of coke is taken as being the amount used per charge before, and 100 lbs. per charge during the above period after conversion, it will be seen that the coke saving is approximately 25 per cent.

During the three months' period the iron melted very hot and was also very fluid. Unfortunately, however, owing to the character of the mixture—high percentage of returned and annealed scrap and sprue—there was experienced what is, more or less, common for malleable founders to encounter, that is, a gradual increase in sulphur content. Therefore, it was deemed advisable to sacrifice some of the savings made by using a cheaper coke and, at present, an equal mixture of the Welsh and cheaper coke is used. It should be noted that the savings detailed later are based on the equally-proportioned mixture.

One of the minor defects during the first few days was rather excessive oxidation of the silicon and manganese, and whilst this was partly due to the high percentage of steel scrap used and the character of this, the oxidation was corrected by adjustments of the blast, and, as before indicated, by closing the top row of auxiliary tuyeres.

Present Practice.

The inside lining is kept at 27 in. This is not at all a difficult matter, since burning out of the lining is not nearly so severe, especially in the melting zone, as was the case before conversion. An endeavour was made to ascertain the erosion of the lining after a 30-ton melt, and Figs. 3 and 4 show the inside of the cupola before and after such a melt.

Further, the conditions of the furnace after dropping at the end of the melt is very good and clean. It was not found that the consumption of ganister showed any appreciable reduction, but there were definite savings in re-bricking and lining costs, for, previous to conversion, it was necessary to rebrick the well and melting zone every three months, and, in addition, 10 to 15 bricks per day had to be inserted in the melting zone. These requirements, at a conservative estimate, would be approximately 5,000 bricks per year, at £10 per 1,000. Therefore, £50 per annum for bricks was saved. It is now rarely ever necessary to insert bricks to bring back the lining to its correct diameter, 1-in. split bricks and ganister being all that is required. To be added to this is the necessary labour charges now saved. Daily re-patching costs, inclusive of material and labour, taken over a period of six months for an average melt of 30 tons per day, are 1s. 3d. to 1s. 4d. per ton of metal melted (7d. for material, and 8d. to 9d. for labour). This, of course, takes no account of the longer life of the lining itself. Neither the malleable nor the grey-iron cupolas have been re-bricked since conversion, although they are just about due for this to take place; the linings have lasted between two and three times as long as previously.

The coke bed in this particular practice is made up to the top row of auxiliary tuyeres, and it is about 54 in. as measured from the bottom of the lining tuyeres. The actual amount of coke used on the bed is 850 lbs. Whilst this is, apparently, appreciably less than before conversion, it should be pointed out that the 1,000 lbs. previously used included the amount of coke required to melt the first charge, whilst the practice after conversion is to put the first charge of coke on after the bed is made up, and it is considered as charge coke. Therefore, the weight of coke used on the bed, in each case, is about the same. However, it should be borne in mind that some 30 or 40 per cent. of the bed coke is recovered, and when good-class coke such as Welsh is used, the condition of the recovered coke is remarkably good; it still retains about 70 per cent. of the original heat value.

Recently there has been appreciable improvements in the coke ratios, compared with those of April 8, 1932. These improvements may be partly due to the reduction in the amount of steel per charge, but, more so, to the result of greater experience with the cupola. At the present time, November 16, 1932, our coke ratio, excluding the bed, 11.5 to 1, using the same equal mixture of cokes, and for a melt of approximately 30 tons per day, the amount of coke per 1,000 lbs. being between 90 and 85 lbs., and when it is realised that this amount of coke is satisfactorily melting a malleable mixture containing practically 25 per cent. of steel, and that the resulting metal is amply fluid for pouring very thin pipe fitting castings from iron containing about 0.7 per cent. of silicon, it will be realised how remarkably efficient is the Fletcher system of balanced blast and the design of the cupola that goes with this system.

The following figures show the coke ratios, including and excluding the bad coke (assuming average melt of 30 tons per day) and using the same percentage of steel in the mixture, before and after conversion, and also the saving effected:—

TABLE II.—*Monetary Results of Conversion.*

	Before conversion.	After conversion.
Average coke per charge.. ..	125 lbs.	90 lbs.
Coke ratio, including bed ..	7.2 to 1	9.6 to 1
Coke ratio, excluding bed ..	8.0 to 1	11.2 to 1
Percentage of coke saving per charge ..	28 per cent.	
Monetary saving—Annual coke requirements before conversion for 30 tons per day melt, less amount required as bed coke, since this is practically the same before and after = 7,500 lbs. per day × 250 (working days)	837 long tons	
Annual coke requirements after conversion = 837 tons, less 28 per cent. ..	603 long tons (approx.)	
Annual cost of coke, when using Welsh coke only at say 48s. per ton, before conversion = 48 × 837	£2,000 0 0	
Annual cost of coke after conversion if Welsh coke only were used = 48 × 603	£1,447 0 0	
Therefore, savings per annum would be ..	£561 0 0	
The present annual cost of coke, due to being able to use 50 per cent. of a cheaper grade average price of mixed coke per ton 42s. 6d. = 42s. 6d. × 603	£1,281 0 0	
Net saving per annum = £2,008 − £1,281	£727 0 0	

If we consider £727 is the net saving per annum, plus £30 for bricks, and not including anything for bricking labour saved or for scrap fall, it will be seen that the whole cost of conversion was paid for in rather less than seven weeks' operation. The savings obtained on the malleable cupola may be expressed in another way; the weekly saving is approximately £15, and, if we consider five days per week, working 30 tons per day, that is, an output of 150 tons per week, it will be seen that the saving is equivalent to a reduction in the cost of metal at the spout of 2s. per ton.

(To be concluded.)

Continental Steel Cartel.

The meeting of representatives of the Continental Steel Cartel which took place in Paris on December 17 was of short duration, and was mainly devoted to the reception of new proposals put forward by the recently-formed Belgian group. The chief difficulty which now faces the Cartel is to settle the question of quotas, as it seems impossible to find a period in recent years which can be accepted as a basis for the calculation of the quotas which would be just and fair to each of the countries concerned, owing to the varied development which has taken place in them. This matter is now to be considered in the light of the statistics placed before the meeting, which is to be resumed on January 12, at Brussels.

Further Notes on Oil-Engine Foundry Practice.*

By Herbert E. Beardshaw, A.R.T.C. (Salford).

Demand for Castings.

Before proceeding to the technical side of this Paper, the author would like to draw the attention of the members to some of the non-technical considerations that are having or will have considerable effect on the industry in general, and whilst attempting to generalise it must be realised that the viewpoint presented will be naturally biased by the oil-engine considerations. The general engineering founder (motive power) had in the past to cater for all types, from the large steam engine down to the small petrol engine such as is used in automobiles; his market was large and it was free from competition—not individual but as an industry. The automobile branch very soon grew too large to be conducted on this basis and required separate and specialised development, with the result that it is now an independent branch of the industry. The large steam-engine section, apart from isolated cases, has apparently died, and another manufacturing section is closed to the founder.

This leaves the intermediate stage, the stage occupied by the gas engine, the smaller Diesel engine, the so-called semi-Diesel engine, and latterly the high-speed Diesel engine—a stage embodying a range of horse-powers, say, from 20 to 30 to 600 to 800. It is with this section that the author is particularly concerned, and his remarks will be from this section's viewpoint.

Now this particular branch of the industry is undergoing a complete change. The gas engine is on the point of passing out and the present trend indicates that the semi-Diesel and/or cold-start semi-Diesel of the slow-speed type seems likely to accompany it, leaving only the high-speed Diesel engine.

It is to be expected, for, from a weight, and therefore conservation of materials point of view, the difference is rather amazing. An engine of the old cold-start, slow-running, oil-engine type, running at 300 r.p.m. and developing 100 horse-power, would weigh approximately 6 tons, of which a high percentage was cast iron, but now an equivalent horse-power can be obtained with material weighing approximately 1 ton, and this is not considering the highly-specialised cases of weight per h.p. reduction such as aero engines. The data are being confined to the class mentioned earlier, or, in other words, a potential user of 100 h.p. now acquires a machine weighing 1 ton, of which not a high proportion is cast iron, as against his previous machine of 6 tons, mostly cast iron. What does this mean to the founder concerned?

It is not proposed to consider the question very deeply from a commercial point of view; that is not the author's province and not the object of these notes, but the output in terms of weight will be lowered considerably, and this necessitates a much lower consumption of materials and labour to attain the same power output.

This point is extended even further when one considers the present position regarding the use of aluminium alloys and welded steel. The use of alternative materials to cast iron is extending considerably, and so the position can be summarised as having been reduced, the founder who previously catered for the medium motive-power demand having his market considerably restricted and having to face the competition of other materials. To overcome this he can either extend his activities to the competing materials or improve his product and methods of production to compete efficiently with these materials, and it is with the second alternative that the author proposes to deal.

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. E. Flower presiding.

Product Improvement.

To improve a product is always a very slow process; numerous engineers are of the opinion that cast iron has reached the limit of its development, so far as ordinary physical properties are concerned. The soundness of this argument is not the subject for discussion here, but one might consider its value as representing the situation. In 1755 cast iron was considered as a material to build bridges, and in 1779 it was actually used to build the bridge at Ironbridge; Tolferd used it frequently just after this period, and the author has in his possession a technical book published in 1873—that is, 60 years ago and 60-70 years after Telford's and John Wilkinson's time—giving the "tensile resistance of cast iron as 7.87 tons per sq. in. and recommending for good cast iron a safe working stress of 1.5 tons per sq. in." Yet in a 1932 engineering handbook under the heading of ultimate stress figures are given as 2½ to 17 tons per sq. in. for cast iron. All founders know the value of such figures, but as judged by the people who purchase the products of the ironfoundry, cast iron has not moved many steps forward in 60 years. A few days ago a prominent technician attached to a well-known firm made the statement that as a certain piece of machinery was stressed to 1.5 tons per sq. in. it must have the finest possible cast iron, and he quoted 20-22 tons for separately-cast test-pieces. When asked why, the reply was that cast iron could not be trusted to be homogeneous. What was meant was that the structure was not likely to be the same throughout, and that, due to design, changes in section, possible draws and excessive graphitisation away from the surfaces, the material would not be capable of safely carrying any further stress. This, then, is the light in which cast iron is regarded by the people using the material, and this impression must be corrected, and the manner in which it should be corrected is the production of high-quality, sound castings.

By the above terms the author means that, when a casting is machined it must not show gas holes, draws, porous spots, sand and other inclusions, because every casting rejected in machining or water testing means another subscriber to the theory that a sound and homegeneous iron casting is a fortunate (but unusual) happening.

It is useless pointing to test-pieces showing 20 tons per sq. in. if the castings represented by those test-pieces fail in service from obviously defective material.

The iron founder then has to improve his product from the above point of view, and not necessarily to concentrate on using ultra-high tensile material. His castings, however, must all be good castings.

An Unusual Waster.

All materials must be examined and used according to the results of that examination. All materials, even the most insignificant, as the following shows:—A rather large but simple casting had been manufactured in high-grade material, such as refined irons, and under careful control throughout. The result on machining was appalling, as a great patch of what would be called "blown" metal appeared in an important part of the casting. An analysis of the bad part revealed a sulphur content of 0.95 per cent. The iron had been carefully checked on receipt, and was purchased to a guaranteed analysis; the coke was in the same category, and the cupola practice was as standard. The moulding, drying and casting were all part of a carefully-controlled system and a difficult problem was set.

One item, however, had not been checked, and the author stumbled upon it luckily. The ladle used was newly daubed, and had been fired the night before. The fire in the ladle had been built of a plentiful supply of wood and ordinary coke, but the wood consisted of rollers from a wallpaper manufactory, and inside each roller was a coating of rock sulphur ½ in. thick. Pounds of sulphur had been melted into the bottom of that ladle, which on receiving the metal had segregated into one huge patch of all types of sulphides and ruined the casting. A complete check on the incoming material would have prevented this.

Of course, this is a very rare case, and is only instanced to show the force of the argument, and it is not necessarily advocated that such extremes should be reached. This examination should be accompanied by a system of records that enables the conditions on any piece of successful work to be repeated on any occasion, irrespective of any intervening variation of conditions. The control exercised with regard to the physical and chemical examination of materials is likely to prove valueless, should that control not be extended to the application of the results of the examinations.

To illustrate the point, a certain piece of work is manufactured successfully from certain materials and under certain conditions of moulding, running and the like, perhaps a fair amount of time and money has been spent in determining these conditions, and two years later the job is to be repeated and the position becomes as follows:—First what material was used, which way was it made, which way was it cast, the type and size of runner, how much camber, what happened after casting, was it "bared" either as a whole or in portions, if so after what interval of time, and a host of questions arise representing queries that have already been solved in the main. Is the success of the job to be dependent upon the manager's, foreman's, metallurgist's, moulder's or coremaker's memory or on all their memories, or should one have changed his sphere of operations, is the job to be a failure?

The control should be extended to cover all these functions, and accurate records be made of all the governing functions of that particular job, but there is no reason why this should not be done, and, what is more, amply justify its existence.

The obvious comment the author will attempt to anticipate, that is, "is it proposed to do always as was done, say two years before?" or, carrying it to the extremes, "as one's grandfathers did?" Obviously one must always be progressive, and the records must not be regarded as the last word on the job. But no matter what progress has been made during the interval between the jobs, the records show what has been done and where one can commence. For instance, should change have been made in material and a low silicon iron be used instead of a medium value? It is easier to make alterations to the existing values of, say, runners, than to take a step in the dark and start from the very beginning.

Practical Aspects.

The author has previously indicated the lines on which the principal metallurgical control runs. To repeat, it is a system of silicon control with the other constituents kept within certain limits. For high-speed oil-engined castings only refined irons are used, and they are all purchased to a specification devised by the author's firm, not the manufacture. This specification is not necessarily rigid to very fine limits, but a certificate of analysis is required with every batch, which certificate is compared with the actual analysis and checked.

The point is that the certificate must represent that batch and not be a general average composition of that particular grade, therefore slight variations do not worry because adjustments can be made to cater for that variation.

This is a prominent feature of the purchase of what are now known as "refined" irons. When a batch of pig-iron is cast from one ladle or furnace, the contents of which ladle or furnace has been thoroughly mixed, and an analysis taken from the ladle, one is reasonable sure of consistency throughout that batch, and the executive makes a point of purchasing "casts," not ordering 5 tons, 10 tons or 50 tons. By leaving the actual weight to the manufacturer and take a complete "cast," he will do everything to assist, because he realises that his goods are dependent upon consistency.

Cupola Practice.

Not all foundrymen realise that one cannot melt high melting-point irons without some addition to the fuel bill. The author has on numerous occasions created consternation by suggesting an increase in fuel when using low silicon irons. Obviously quantities must be carefully measured and every condition rendered as stable as possible. Ironfounders must realise that the greatest adjustments to the characteristics of an iron can be made at this stage. Variations in cupola practice are accompanied by considerable variation in these characteristics, and all founders now realise that two irons of very similar chemical analysis can present very different physical properties. The "germ theory" throws considerable light on this point, instancing as it does the tremendous effect of "super heating" and the resultant state of the graphitic carbon.

For the proper working, the bed must be carefully standardised, using a known weight of fuel, and filling to a definite predetermined height above the tuyeres. Care must be taken to keep the charges level, and blast pressure and volume unaltered throughout the cast.

There have been many discussions as to the measure of success attending the practice of using a cupola to give several different types of iron in the course of one period of melting. It is common practice to obtain several different types throughout the course of one cast within reasonably close limits, *i.e.*, there is not a great amount of overlap between the different types. The best practice is to commence the cast with the lowest silicon-content type and gradually move up the scale of silicon content. This is a general statement and is, of course, subject to amendment in detail.

A typical cast will run as follows: A small charge of material intended for the pig bed is melted; its function is generally to absorb the excess sulphur in the bed fuel and generally enable the cupola to be warmed up. Then follows the lowest silicon iron, probably a ton or 30 cwts. of 0.8 to 0.9 per cent., followed by, say, 30 cwts. to 2 tons of 1 per cent. Si metal after one of 30 to 40 cwts. of 1.25 per cent. Si iron. Then perhaps 3 to 4 tons of 1.7 to 1.8 per cent. Si metal and any special mixtures for work that may not be in the best category and yet it is not desirable to cast in absolutely common material, and finally the general common cast iron at the end of the cast.

The overlap is not great, due to the methods of cupola charging, *i.e.*, uniform sizes and intelligent placing of the material in the cupola. It is, of course, charged by hand. It is usually arranged that the overlap weight is used in work the analysis of which is not vital to within the limits of any two successive mixtures, but this is only a safety measure, and it can be instanced that samples of metal taken from the cupola at intervals of 1 to 2 min. have exhibited the characteristics and analysis of the two mixtures concerned. This is made possible, again, by melting to a time schedule, for if the original control is good this schedule will hold from day to day. Occasionally it is realised that conditions are such that the overlap period cannot be determined exactly, and several cwts. are poured away on the pig bed for analysis and re-grading, as an alternative to casting a "waster." It is also essential that the runners, risers, heads, etc., from each individual mixture must be returned to the scrap stack of that mixture and not indiscriminately mixed. This extends to the smallest head and is rigidly enforced.

It is seriously wrong to have the metal available for moulds that are not ready to receive it. For the metal being so held is losing heat very rapidly and, furthermore, the moulds are being rushed to accommodate the metal. Conditions are ideal for the production of wasters and thus contribute more to the "unreliable cast iron" idea.

Handling of the Material.

A leading article in THE FOUNDRY TRADE JOURNAL, some time ago, considered the old saying "Where there's muck there's money," and pointed out the obvious fallacy. The author would like to confirm this point of view and coin another expression "Where there is muck there are wasters." Clean ladles and shanks are essential. There is too much risk with dirty ladles, and to assist this policy all spare metal should be poured away before it reaches the stage when it simply freezes on the side and lip when being poured out.

(*To be concluded.*)

The Idle Thoughts of a Busy Fellow.

By G. ERNEST WELLS (Director, Edgar Allen & Company, Limited).

The position to-day is that everybody is starving for work, and as far as I can see, is likely to continue to do so. Comparing the general situation pre-war and post-war, it should be realised that to-day there is more steel-foundry area available than there was prior to 1914. In addition, equipment has improved substantially, so that on a given area may be produced more castings than on the same space previously; and finally and most important of all, the moulder is to-day willing to work under systems of payment by results instead of on datal rates, with the consequence that in many cases his output may easily be doubled. If these fundamental facts are realised, it should be easy for the simplest mind to appreciate the impossibility of employing the whole capacity of the existing steel foundries within the lifetime of any of those engaged in the industry to-day, unless one is to envisage another world war, which would be the end of all things. It would appear, then, absolutely essential that steps should be taken to reduce capacity. This *can* be done by the operation of the law of the survival of the fittest, and I have been accused by many friends and competitors of recommending this process; but I take this opportunity of categorically denying ever having done so. I have enough sense to realise that an individual may go into a free fight and come out alive, but at the same time may be permanently maimed as the result of the encounter. That is exactly what would happen if the foundries embarked on a scheme of cutting one another's throats in an effort to eliminate the unfit. My own definite view is that some better way could and should be found in order to get us out of our present dilemma. In my judgment there are a number of steel foundries in this country which should close their doors, and, speaking as an individual, I think it is only fair that they should be compensated for doing so by means of a fund raised by those who continued in operation. I appreciate the difficulties of the proposal, but I am not prepared to admit that they are insuperable. Other industries have dealt with a similar situation successfully, and in my opinion a steel founder has as much common sense as a miller. What I do feel is that unless the industry itself can devise a means by which it can operate on economic lines, pressure will be brought to bear on it from outside sources. The tariffs were imposed on imported steel castings with the object of keeping them out of this country altogether, but it does not seem rational to demand that those tariffs should be maintained or extended if they do not serve the purpose of putting the steel foundries on their feet. I am aware that in the minds of some of my competitors the view is strongly held that we should band together and refuse to sell at figures below cost of production. This proposal leaves me quite cold, as I am satisfied that costs of production cannot be brought down to an economic basis in any plant which is not occupied to a reasonable percentage of its capacity.

This brings us back once more to the question of reducing capacity to a figure nearer to the demand likely to be made upon the steel foundries, which are working to-day at 25/30 per cent. of their maximum output. Government action, apart from taking off the tariff, would appear impossible, but it may be that one day the people who provide the wherewithal to carry on will kick. I am of far too humble a disposition to presume to offer advice to those gentlemen who control the finances of the country; but I can at least express the view that if I were a banker, I would prefer six sound accounts to twelve doubtful ones. I do not know enough of banking policy to make any suggestion; but it may be that the prosperity of a bank is measured by the amount of money it has on loan uncovered by any realisable security. What I mean is that a house which cost £1,000 to build and which is situated in a highly-populous district where there is a demand for houses may be a real asset. An exactly similar house in a district which is being deserted, and where there is no possibility of letting it, may be an actual liability. In the same way, if a works that had fixed assets in the form of buildings, plant and machinery, were engaged in production to a reasonable percentage of its possible output, its fixed assets might be a valuable asset on which to advance working capital. If, however, that same works is only occupied to 25 or 30 per cent. of its possible output, the security provided by its fixed assets would be very small. It seems to me that the security which the works provides is exactly equal to its market value, and there are very few people to-day who would be willing to buy a steel foundry at a figure above its value for breaking-up purposes.

As far as I can see, my remarks on the Steel Foundry situation apply with equal force to most other branches of the steel industry. Everywhere in the country we see steel plant which is not at work, and there does not appear to be the slightest prospect of its ever again being in full operation. During the pre-war period expansion went on normally, in accordance with the increase of the order-books of each individual industry. The war saw further and vast increases, and even during the immediate post-war period extensions were carried out. The expansion was abnormal, and my own view is that a corresponding contraction will have to take place preferably by artificial means contrived on common-sense lines. The alternative is a fight to the finish with the prospect of many of the survivors being maimed.

If the Editor cares to print the foregoing I am quite willing that he should do so, and if his readers disagree with the views I have put forward, I hope they will write to him and say so. I would ask them, however, to read what I have said with due care, and in their criticisms to put forward constructive proposals.—"Edgar Allen News."

THE NORTH EASTERN MARINE ENGINEERING COMPANY, LIMITED, have received an order to supply triple-expansion engines of 630 i.h.p. for a steamer now being built at Burntisland for the Constantine Steamship Company, Limited, Middlesbrough. The work will be carried out at the engineering firm's Sunderland works.

This Week's News in Brief.

Trade Talk.

Mr. Richard Sidney Clayton, carrying on business at 7a, Pitt Street, Norwich, ironfounder, has been adjudicated bankrupt.

Messrs. Dorman, Long & Company, Limited, of Middlesbrough, have secured an order for 4,000 tons of tram rails for the London County Council.

Messrs. Bruce Peebles & Company, Limited, Edinburgh, are closing their works on Friday evening, December 30, until Monday morning, January 9, 1933.

A survey of the facilities available for new industries is being undertaken by the Industrial Development Council of South Wales and Monmouthshire.

The Davum Steel Company, Limited, have removed their offices from Bush Lane House, Bush Lane, London, E.C.4, to Aldwych House, London, W.C.2.

An important contract for electrical switchgear for the Capetown Corporation has been received by Messrs. A. Reyrolle & Company, Limited, Hebburn-on-Tyne.

Imports of machinery into Malaya during the first half of the current year represented a total value of £295,497, as compared with £497,915 during the corresponding period of 1931.

The new destroyer "Dainty," built by the Fairfield Shipbuilding & Engineering Company, Limited, has been carrying out acceptance trials on the Firth of Clyde during the week.

An order for eight Pacific-type locomotives and tenders has been placed with the North British Locomotive Company, Limited, Glasgow, by the Tientsin Pukon Railway, China. The locomotives, which are for the 48½-in. gauge, have cylinders of 20-in. dia. and 28-in. stroke and superheater boilers.

The second annual dinner of the West Riding of Yorkshire Branch of the Institute of British Foundrymen has been arranged to take place on Saturday, January 14, at the County Restaurant, Bradford, and will be open to members and their ladies. A concert party has been engaged.

The combine of six Lancashire firms which was registered in September last year as Textile Machinery Makers, Limited, has decided to concentrate production by suspending work temporarily at three centres. The other three, Howard & Bullough's, Accrington, Platt Bros., Oldham, and Brooks & Doxey, West Gorton, Manchester, will carry on, while Dobson & Barlow, Bolton, John Hetherington, Ancoats, Manchester, and A. S. A. Lees, Oldham, who are directly affected, will retain sufficient men to continue the supply of spare parts.

Mr. Andrew Hamilton, of Liverpool, addressing the members of the Tees-side Branch of the North-East Coast Institution of Shipbuilders and Engineers at Middlesbrough on the rejuvenation and reconditioning of ships and their machinery, said there was ample room and call for some new prime mover. Just as the Parsons turbine came in 20 years ago at a time when higher power, speed and economy were in demand, so a new prime mover was needed to-day. Engineers in this country, and more particularly on the Continent, were carefully investigating the possibilities of the improved steam engine.

In a report issued as a White Paper the Standing Committee under the Merchandise Marks Act recommends that imported revolving chucks for lathes and other machine tools (but not including spring collets) should be required to bear an indication of origin on sale and exposure for sale, both wholesale and retail, die-stamped or otherwise incised in a conspicuous manner on the face of the chuck body. If the Board of Trade decides to give effect to the recommendation the committee suggest that the order should come into force three months after the date on which it is made.

Messrs. Lodge-Cottrell, Limited, have recently received the order for an interesting blast-furnace gas-cleaning plant from the British (Guest Keen Baldwins) Iron & Steel Company, Limited, for their Margam Works. This is part of a fuel-economy programme. It is intended to utilise the blast-furnace gas to the greatest possible advantage. This plant is in addition to the company's existing Halberg-Beth installation, and will have a capacity of one million cub. ft., measured at N.T.P. per hour. The guaranteed degree of cleaning is 0.02 grain per cub. ft. The new plant will be very similar to the Lodge-Cottrell installations elsewhere in this country, but whereas the older plants were only intended to give rough cleaning, recent developments and improvements in control make it possible to give fine cleaning consistently in such plants, thus increasing the effective thermal value of the gas. The automatic control reduces still further the operating costs.

At a meeting of the Institution of Automobile Engineers, to be held at the Royal Society of Arts, John Street, Adelphi, London, W.C.2, on Tuesday, January 3, 1933, at 7.45 p.m., Mr. E. A. Watson will read a Paper entitled "Electrical Equipment for Automobiles." Mr. Watson has been known as a specialist in this subject for many years, and his Paper will be of great interest as recording the latest progress in this important aspect of automobile engineering. Mr. Watson will also read his Paper at the following provincial centres of the Institution:—Birmingham, Wednesday, January 4, at the Queen's Hotel, at 7.30 p.m.; Coventry, Tuesday, January 10, at the King's Head Hotel, at 7.30 p.m.; Glasgow, Monday, January 16, at the Institute of Engineers and Shipbuilders, 39, Elmbank Crescent, at 7.30 p.m.; Leeds, Wednesday, January 18, at the Metropole Hotel, King Street, at 7.15 p.m.

Cards of admission to any of the above meetings may be obtained on application to the secretary, the Institution of Automobile Engineers, Watergate House, Adelphi, London, W.C.2.

Personal.

Mr. Myron C. Taylor, chairman of the United States Steel Corporation, is paying a short visit to this country.

The telephone number of Mr. Wesley Lambert's home address at 28, Canadian Avenue, Catford, S.E.6, has been changed to Hither Green 3247.

Mr. Lennox Holt, who has changed his address to 96, Fordhook Avenue, Ealing Common, London, W.5, announces that his telephone number is now Acorn 0311.

Sir George Hunter, the veteran shipbuilder, of Messrs. Swan, Hunter & Wigham Richardson, Limited, Wallsend, celebrated his 87th birthday on Monday, December 19.

Mr. and Mrs. W. Thornton, of 71, Parkside Road, West Bowling, Bradford, have celebrated their golden wedding. Mr. Thornton is director and secretary of Yorkshire Repetition Castings Company, Limited, which he founded in conjunction with Mr. W. G. Thornton, his son, some six years ago. Mr. W. G. Thornton is a prominent member of the Institute of British Foundrymen.

Wills.

Thompson, Errol Hay, of Sunderland, shipbuilder	£44,789
Dowson, Fred, of Eccles, director of Messrs. Mather & Platt, Limited, engineers	£37,587
Wheatley, T. A., chairman of Messrs. Beck & Company, Limited, hydraulic engineers, London, S.E.	£49,008

Contracts Open.

Cairo, January 9.—Two pumping units, for the Egyptian Ministry of Public Works. The Department of Overseas Trade. (Reference G.X. 12,089.)

Liss, January 5.—4-in., 5-in., 6-in., 7-in. and 9-in. cast or spun iron pipes, all in 12-ft. lengths only, and special castings, for the Petersfield Rural District Council. Mr. H. C. Adams, consulting engineer, 60, Queen Victoria Street, London, E.C.4. (Fee £3, returnable.)

London, W., January 3.—Iron and steel stores, for the Great Western Railway Company. The Stores Superintendent, Swindon.

Swansea, January 6.—150-ton overhead electric travelling crane and 15-ton overhead electric travelling crane, for the Corporation. Messrs. Preece, Cardew & Rider, consulting engineers, 8, Queen Anne's Gate, Westminster, S.W.1. (Fee £5 5s., returnable.)

Obituary.

Mr. E. G. Matheson, assistant chief engineer of the Great Western Railway, died at his home at Ealing recently.

Mr. Charles Magee, manager of the Belfast branch of Messrs. W. T. Henley's Telegraph Works Company, Limited, died recently.

The death occurred of Mr. James Joseph Moyers, aged 69, of Billinge, Lancs, who for many years was in business as an iron and steel broker.

We learn with sincere regret of the death, at the age of 76, of Mr. J. W. Wilson, managing director, Messrs. Wilsons & Mathiesons, stove grate founders, of Leeds, and a director of the London Scottish Foundry of Barking. He was a brother of Mr. Henry Wilson, who is usually credited with the invention of the gas fire for domestic heating. The firm was created by Mr. Wilson's father, Mr. Charles Carr Wilson, in 1854, and in 1889 it was amalgamated with Mathiesons. In 1920 the firm became associated with the Radiation Group.

Mr. Frederic John Stephen, chairman of Messrs. Alexander Stephen & Sons, Limited, shipbuilders, Linthouse, Glasgow, died on December 16. Mr. Stephen was President of the Clyde Shipbuilders' Association, and had been for some years a member of the Council of the Institution of Naval Architects, while he was also a member of the Institution of Engineers and Shipbuilders in Scotland. He was a member of the general committee of the British Corporation Register of Shipping and Aircraft, and chairman of the technical committee of the society. Mr. Stephen was also chairman of the Steel Company of Scotland, Limited.

Mr. Archibald Gilchrist, one of the best-known engineers on the Clyde, chairman of Messrs. Barclay, Curle & Company, Limited, Glasgow, died at his home in Glasgow on December 22. Mr. Gilchrist, who was President of the Institution of Engineers and Shipbuilders in Scotland, is the third chairman of Clyde firms to die during December. He represented the third generation of his family who has been closely identified with Barclay, Curle & Company, of which he became chairman two years ago. He was also a director of Messrs. Swan, Hunter & Wigham Richardson, Wallsend-on-Tyne. Mr. Gilchrist joined the firm of Barclay, Curle & Company over 30 years ago, and rose rapidly to a position of responsibility having, after serving his apprenticeship, gained practical experience at sea. In 1902 he became assistant manager of the Stobcross Engine Works. He was appointed engineering director in 1915, and for his activities during the war years he was awarded the O.B.E. Among the engineering enterprises for which Mr. Gilchrist was responsible was the construction of the oil engines for the motorship "Jutlandia," which were the first engines of the internal-combustion type to be manufactured in this country for marine purposes.

We very sincerely regret to announce the death of Mr. Fred J. Taylor, O.B.E., J.P., managing director of Taylor & Sons, Briton Ferry, which occurred last Tuesday night. Mr. Taylor was one of the outstanding characters in the industrial life of South Wales. He was President for many years of the Welsh Engineers' and Founders' Association, and in this capacity it fell to his lot to negotiate wages agreements with the operatives, and in doing so he invariably managed to retain the goodwill of both sides. He was one of the oldest members of the Institute of British Foundrymen, having joined in 1905, the year after its establishment as the British Foundrymen's Association. He was an extremely enthusiastic educationalist in so far as it related to the training of apprentices and Swansea University College has, through its officers, often expressed its appreciation of the help accorded by Mr. Taylor. On the last occasion we met Mr. Taylor he was discussing with us the plans he and his colleagues were making for entertaining the visitors to the next Foundrymen's Conference, which is scheduled to be held in South Wales. Mr. Taylor's firm, though normally specialising in the production of plant for the tinplate industry—especially pickling machines, which are exported all over the world—was the first firm to convert an ordinary engineering shop into a shell factory. We always regarded Mr. Taylor as the wittiest speaker in the foundry industry, and his brilliant oratory will be missed for many years. The industry has lost one of its most efficient leaders, and many of us a sympathetic and sincere friend. To his relatives we offer our deepest sympathy.

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The way to BETTER castings

WARNER & CO. LTD. CARGO FLEET MIDDLESBROUGH

COMPRESSORS

& DRY VACUUM PUMPS

FOR AIR OR GAS.

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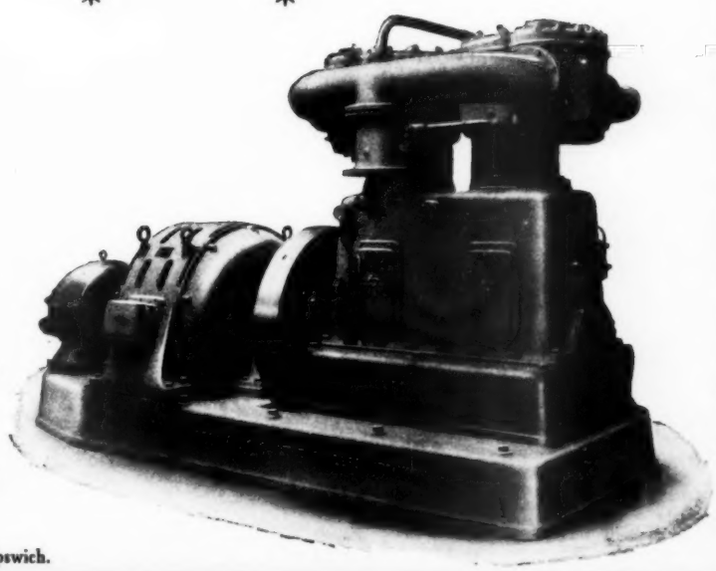

These double-acting cross-head type Compressors are provided with forced lubrication. They may be driven by any suitable power unit, or by steam cylinders in tandem with the compressor cylinders making a self-contained unit.

Single Stage. Pressures up to 40 lbs. per sq. in. Capacities up to 10,000 cu. ft. per min.

Two Stage. Pressures up to 120 lbs. per sq. in. Capacities up to 5,000 cu. ft. per min.

For particulars of these machines and for other types write (mentioning this journal) to:—

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Ranelagh Works, Ipswich.

Telegrams: "Reavell, Ipswich." Telephone Nos. 2124 & 2125 Ipswich.

Raw Material Markets.

There is, of course, little change to report this week in the iron and steel markets, owing to the intervention of the holidays. The markets have not yet resumed their normal activity, and will not do so for another week or two, as most consumers recently took in fair stocks. It is considered that the prospects for the New Year's trading are more favourable than they have been for some time, as the industry is now strengthened by a protected home market and by the granting of a measure of Imperial preference. Business with foreign countries has also shown an increase during the last two or three months.

Pig-Iron.

MIDDLESBROUGH.—News has been forthcoming this week of a scheme for reopening the pig-iron warrant stores. Messrs. Connal & Company, who formerly owned the warrant stores at Middlesbrough and Glasgow, are said to be arranging for the issue of a form of warrant, on the old lines, for Cleveland iron at the South Bank store, Middlesbrough, for standard iron at Connal's stores at Grangemouth and Glasgow, for mixed numbers East Coast hematite at Middlesbrough and for West Coast hematite at the Furness Railway Company's store. Whether the scheme will be accepted remains to be seen. Business was quite brisk just before the holidays, consumers, many of whom are almost bare of stocks, contracting ahead for periods up to three months. Price concessions are still offered to Scottish buyers, but for local consumption the following are the minimum figures which are being accepted:—No. 1 Cleveland foundry iron, 61s.; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

Recent sales of East Coast hematite have just about absorbed the production, and the market enters the New Year upon an even keel. Prices, however, are still at a low level, mixed numbers being obtainable at about 59s. per ton, with 6d. extra for No. 1 quality. On the West Coast Bessemer mixed numbers remain at 66s. per ton.

LANCASHIRE.—Several more contracts for delivery over the next quarter were taken last week, but it is not likely that there will be any general departure from the policy of hand-to-mouth buying that has been so prevalent during 1932. Foundry-iron prices are held on the basis of 67s. per ton for Staffordshire, Derbyshire and North-East Coast brands of No. 3, with Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at around 82s. 6d., West Coast hematite at about 81s., and East Coast at 76s., including delivery to works in the Manchester district in each case.

MIDLANDS.—The chief consumers in this district have already contracted for their supplies over the next three months, but there are still many small foundries that are working on small parcels of iron bought as the need arises. The furnaces are carrying heavy stocks of iron into the New Year, which have been further augmented during the present month. Prices remain unaltered at 62s. 6d. for Northants No. 3 and 66s. for North Staffordshire, Derbyshire and Lincolnshire No. 3, including delivery to Birmingham and Black Country stations. Cleveland No. 3 is quoted at 66s. per ton, delivered this area.

SCOTLAND.—Many of the foundries are closing down for longer periods than usual, in the hope of accumulating orders to resume on, and everything points to a slow start in 1933, particularly owing to the inactivity in shipbuilding. The official price of 67s. 6d. for No. 3 foundry, f.o.t. furnaces, is still in force, with 2s. 6d. per ton extra for No. 1. No. 3 Middlesbrough is still at about 54s. at Falkirk.

Scrap.

Business has been brisker on the Cleveland market. Ordinary heavy scrap iron is still obtainable at 37s. 6d., but up to 42s. is quoted for machinery quality. There is a steady demand in the Midlands, where machinery metal is offered at 45s. to 47s. 6d., with clean light at 36s. per ton, delivered works. There is a better inquiry in Scotland for machinery cast-iron scrap, which is firm at 45s., in pieces not exceeding 1 cwt., and for ordinary cast iron at 39s. to 40s. Heavy cast iron is in better demand in South Wales at 42s. 6d. per ton.

Coke.

There has been no change in conditions on the foundry-coke market. Little forward buying has taken place. For delivery in Birmingham and district, best Durham brands are quoted at from 36s. 6d. to 38s., and Welsh prices vary according to quality from 30s. up to 45s. per ton.

Steel.

Conditions in the iron and steel markets remain fairly steady. The demand for finished steel has fallen away slightly. Foreign small steel bars are again competitive in this country, the price, delivered Birmingham, being about 10s. below the home re-rollers' quotation. With regard to semi-finished steel, heavy stocks are held by consumers, and there will not be a great deal of activity in the market until well into the New Year.

Metals.

Copper.—The price of this metal has shown an increase during the past fortnight and consumers, who bought one or two lots at the previous lower levels, have held off the market to a large extent. Consumers are awaiting the announcement of the producers' policy for 1933. Since the failure of the recent conference, it is unlikely that there will be any sudden expansion of outputs, in view of the immense stocks now existing. It is more likely that there will be a gradual, but limited, increase in the rate of production of the more favourably situated low-cost mines. At all events, it is doubtful whether we shall see standard copper above £30 for another month or two.

Closing quotations :—

Cash.—Thursday, £28 1s. 3d. to £28 2s. 6d.; Friday, £28 2s. 6d. to £28 5s.; Wednesday, £28 10s. to £28 12s. 6d.

Three Months.—Thursday, £28 7s. 6d. to £28 8s. 9d.; Friday, £28 8s. 9d. to £28 11s. 3d.; Wednesday, £28 17s. 6d. to £29.

Tin.—International consumption of this metal remains limited, and the prospects for the New Year are not very good. The chief demand in this country continues to be from the South Wales tinplate producers, who are shortly to increase their output.

Official closing prices :—

Cash.—Thursday, £148 10s. to £148 15s.; Friday, £148 12s. 6d. to £148 15s.; Wednesday, £148 7s. 6d. to £148 10s.

Three Months.—Thursday, £149 17s. 6d. to £150 2s. 6d.; Friday, £149 17s. 6d. to £150; Wednesday, £149 15s. to £150.

Spelter.—Business during the past week has naturally given little to report, but activities should be resumed in the next few days. Some doubt has recently been expressed as to the unanimity of the producers with regard to the self-imposed restrictions on output.

Daily fluctuations :—

Ordinary. — Thursday, £15 7s. 6d.; Friday, £15 7s. 6d.; Wednesday, £15 8s. 9d.

Lead.—The spring demand shows little sign of exceeding that experienced during recent months. At the end of the year attention is drawn to the immense stocks of surplus lead being carried forward, an amount which is variously estimated at upwards of 500,000 tons—sufficient alone to meet world consumption for a very long time.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11; Friday, £10 16s. 3d.; Wednesday, £10 15s.

Company Reports.

Amalgamated Metal Corporation, Limited.—Usual half-yearly dividend on the 6 per cent. preference shares.

Greenwood & Batley, Limited.—The interim preference dividend of 3¼ per cent. will be paid on December 30. The directors are deferring consideration of a dividend on the ordinary shares until the full results for the year are available.

Students' Corner.

Q.—When charging the cupola for a "blow" what should be the depth of the bed charge of coke?

Answer Concluded.

It must be clearly understood that the bed charge should be always constant whether the "blow" is for five or fifty tons, the depth of coke should be the same. Some obviously wrong ideas are common regarding this matter. The bed charge of coke does not carry the "blow" through. It is a waste of coke and time to increase the coke bed for a long "blow." Every cupola determines its own melting zone, that is, its position, hence the metal will be longer coming down than is usual when the bed charge is kept constant. It is the coke between the charges of metal that effects the actual melting, some of which also reinforces the bed of coke underneath the tuyeres and carries the burden. It is obvious if a cupola is in blast for 8 hours, in less than half of that time none of the original coke bed, whether above the tuyeres or underneath the tuyeres will be left, but rather the ash from it will be fluxed off from it through the slag hole.

Q.—What should be the distance from the tuyeres to the charging door?

A.—This to some extent depends upon the diameter of the cupola. As a rule the larger the diameter of the cupola the greater should be the height. The larger the cupola the more rapid the melting, hence it is not reasonable that all cupolas should be the same height. The ideal sought is—that the whole of the burden comprising coke, metal and limestone, as it descends from the charging door should be heated to that extent that by the time it reaches the melting zone the metal will run through like rain, and the limestone will unite with the ash and siliceous matter forming a free flowing slug. With large cupolas, say over 60 in. dia., if the distance between the charging door and melting zone is not sufficient, the burden is falling so rapid, due to quick melting, that chunky pieces of scrap, or even a thick half sow of iron will pass through the melting zone and rest on the bottom of the cupola, there it may melt by other molten metal around, causing to some extent dull iron, or it may lie there until the cupola is raked out, or the bottom falls, as the case may be This has occurred many times. The following is submitted from experience as reasonable :—

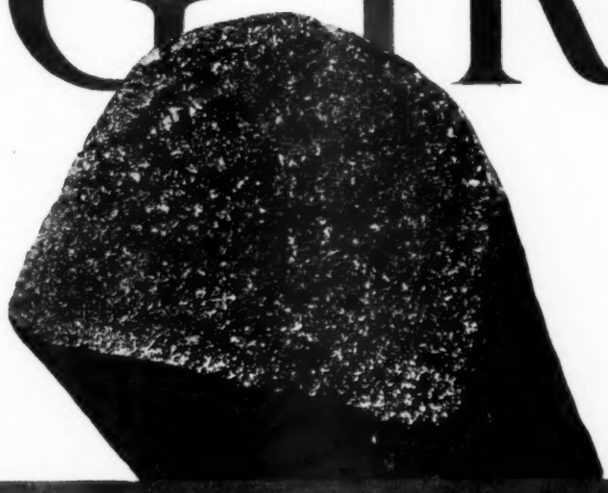
Depth from tuyere level to charging door sill.

Min. distance for	**24**	**dia. cupola,**	**6**	**ft.**
,,	,, **36**	,,	**8**	,,
,,	,, **48**	,,	**10**	,,
,,	,, **60**	,,	**12**	,,
,,	,, **72**	,,	**14**	,,

(To be continued.)

XUM

PIG IRON



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OF ALL KINDS FOR IRON AND STEEL WORKS

Iron Castings up to 100 tons each. Steel Castings up to 40 tons each.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	28	10	0
Three months	28	17	6
Electrolytic	33	15	0
Tough	30	0	0
Best selected	30	10	0
Sheets	61	0	0
India	41	0	0
Wire bars	34	0	0
Do., Feb.	34	2	6
Do., March	34	5	0
Ingot bars	34	0	0
H.C. wire rods	37	0	0
Off. av. cash, November	32	0	4 1/16
Do., 3 mths., November	32	5	0 15/16
Do., Sttlmnt., November	32	0	5 3/16
Do., Electro, November	36	17	10 1/16
Do., B.S., November	34	19	8 3/16
Do., wire bars, November	37	4	1 1/16
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6½d.

BRASS.

Solid drawn tubes	8½d.
Brazed tubes	10½d.
Rods, drawn	7½d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£	s.	d.
Standard cash	148	7	6
Three months	149	15	0
English	149	0	0
Bars	152	5	0
Straits	153	17	6
Australian	152	2	6
Eastern	153	0	0
Banca	154	12	6
Off. av. cash, November	153	13	3 6/11
Do., 3 mths., November	154	11	7 17/22
Do., Sttlmt., November	153	13	4 10/11

SPELTER.

	£	s.	d.
Ordinary	15	8	9
Remelted	15	0	0
Hard	13	0	0
Electro 99.9	17	15	0
English	16	7	6
India	14	10	0
Zinc dust	22	0	0
Zinc ashes	2	15	0
Off. aver., November	15	7	11 35/44
Aver. spot, November	15	5	3 9/22

LEAD.

	£	s.	d.
Soft foreign ppt.	10	15	0
Empire	11	2	6
English	12	5	0
Off. average, November	12	4	7 1/2
Average spot, November	12	1	5 1/22

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	15	0
Do., V.M. ex-whse.	24	5	0
Rods	27	0	0
Boiler plates	23	0	0
Battery plates			—

ANTIMONY.

	£	s.	d.
English	37 10 0 to 42	10	0
Chinese	27	0	0
Crude	19	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 0 0
45/50%	£13 15 0
75%	£19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£18 7 6
Ferro-tungsten—	
80/85%	1/7½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
2/4% car.	£32 10 0
4/6% car.	£25 0 0
6/8% car.	£24 17 6
8/10% car.	£23 10 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£40 2 6
Max. 0.70% car.	£43 12 6
70% carbon-free	1/- lb.
Nickel—99.5/100%	£250 to £255
"F" nickel shot	£225 0 0
Ferro-cobalt	7/3 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel				2	0	0
Bundled steel and shrngs.	1	15	0 to	1	19	0
Mixed iron and steel	1	14	0 to	1	16	0
Heavy cast iron				2	2	6
Good machinery	2	5	0 to	2	7	6
Cleveland—						
Heavy steel				2	0	0
Steel turnings				1	12	6
Cast-iron borings				1	3	6
Heavy forge				2	10	0
W.I. piling scrap				2	2	6
Cast-iron scrap	1	18	6 to	2	2	0
Midlands—						
Light cast-iron scrap				1	16	0
Heavy wrought iron				2	5	0
Steel turnings, f.o.r.				1	0	6
Scotland—						
Heavy steel	1	15	0 to	1	17	6
Ordinary cast iron				1	19	6
Engineers' turnings				1	9	6
Cast-iron borings				1	10	0
Wrought-iron piling				1	19	0
Heavy machinery				2	5	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	21	0	0
Brass	14	0	0
Lead (less usual draft)	10	0	0
Tea lead	8	10	0
Zinc	8	10	0
New aluminium cuttings	72	0	0
Braziery copper	19	0	0
Gunmetal	18	0	0
Hollow pewter	80	0	0
Shaped black pewter	60	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
,, at Falkirk	54/-
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	59/6
Hematite M/Nos.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	61/-
,, No. 3 fdry.	66/-
Northants forge	57/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	61/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
,, basic	—
Scotland—	
Foundry No. 1	70/-
,, No. 3	67/6
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	58/6
,, fdry. No. 3	63/6
Lincs forge	—
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
,, fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	7	15	0 to	8	0	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.	13	0	0			
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	7	6 to	9	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)	6	15	0 & up.			
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	10	0 to	10	10	0
Black sheets, 24g. (10-t. lots)	9	5	0			
Galv. cor. shts. ,,	11	5	0			
Galv. flat shts. ,,	11	15	0			
Galv. fencing wire, 8g. plain	14	0	0			
Billets, soft	4	17	6 to	5	7	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	2	6
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	10½d.
Tubes	16d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.10
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 25/-
,, furnace	16/- to 17/-
Durham and Northumberland—	
,, foundry	21/- to 25/-
,, furnace	13/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	16/-
,,	28×20 ,,	32/-
,,	20×10 ,,	23/-
,,	18¾×14 ,,	16/7½
C.W.	20×14 ,,	13/9 to 14/9
,,	28×20 ,,	29/3 to 29/6
,,	20×10 ,,	19/10
,,	18¾×14 ,,	14/-

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.	
Dec.	22 ..	28 1 3	dec. 12/6
,,	23 ..	28 2 6	inc. 1/3
,,	28 ..	28 10 0	,, 7 6

Standard Tin (cash).

		£ s. d.	
Dec.	22 ..	148 10 0	dec. 10/-
,,	23 ..	148 12 6	inc. 2/6
,,	28 ..	148 7 6	dec. 5/-

Spelter (ordinary).

		£ s. d.	
Dec.	22 ..	15 7 6	dec. 1/3
,,	23 ..	15 7 6	No change
,,	28 ..	15 8 9	inc. 1/3

Zinc Sheets (English).

		£ s. d.	
Dec.	22 ..	24 10 0	No change
,,	23 ..	24 10 0	,, ,,
,,	28 ..	24 10 0	,, ,,

Electrolytic Copper.

		£ s. d.	
Dec.	22 ..	33 10 0	No change
,,	23 ..	33 15 0	inc. 5/-
,,	28 ..	33 15 0	No change

Tin (English ingots).

		£ s. d.	
Dec.	22 ..	149 5 0	dec. 5/-
,,	23 ..	149 5 0	No change
,,	28 ..	149 0 0	dec. 5/-

Spelter (Electro, 99.9 per cent.).

		£ s. d.	
Dec.	22 ..	17 15 0	No change
,,	23 ..	17 15 0	,, ..
,,	28 ..	17 15 0	,, ..

Lead (English).

		£ s. d.	
Dec.	22 ..	12 10 0	dec. 5/-
,,	23 ..	12 10 0	No change
,,	28 ..	12 5 0	dec. 5/-

AVERAGE MONTHLY PRICES OF STEEL RAILS.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1917	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1918	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6	10 17 6
1919	10 17 6	13 7 6	13 7 6	13 7 6	15 0 0	15 10 0	16 0 0	16 10 0	16 10 0	16 10 0	16 10 0	17 5 0	14 12 11
1920	18 15 0	19 5 0	20 7 6	22 0 0	23 0 0	23 0 0	24 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	22 18 11½
1921	23 5 0	20 4 0	18 0 0	17 0 0	15 0 0	15 0 0	14 0 0	14 0 0	14 0 0	11 12 6	10 10 0	10 0 0	15 4 3
1922	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 0 0	8 15 0	8 15 0	8 15 0	8 15 0	9 4 2
1923	8 17 6	9 2 0	10 5 0	10 10 0	10 10 0	10 10 0	9 15 0	9 0 0	8 15 0	8 15 0	8 19 0	9 5 0	9 9 10
1924	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 2 6	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 2 3½
1925	9 0 0	9 0 0	9 0 0	9 0 0	8 15 0	8 10 7½	8 10 0	8 10 0	8 10 0	8 4 0	8 0 0	8 0 0	8 11 7½
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11½
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1930	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1931	8 9 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 8
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE AT MIDDLESBROUGH.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1916	133 9	140 6	136 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	128 1½
1917	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1918	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6
1919	122 6	122 6	122 6	122 6	179 2	190 0	197 6	200 0	200 0	200 0	200 0	200 0	171 4
1920	220 0	220 0	240 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	260 0	251 8
1921	240 0	220 0	180 0	180 0	180 0	160 0	160 0	160 0	137 0	127 6	117 6	104 6	162 2
1922	97 6	91 7½	100 0	98 6	97 1½	94 7	93 6	90 9	89 7	91 10½	93 0	93 2	94 5½
1923	94 6	104 9	122 0	126 10½	122 0	115 3	107 0	98 8½	98 10½	99 1½	100 6½	102 3	107 10½
1924	102 4½	101 3	99 7½	99 0	98 9½	97 4½	95 3½	93 1½	90 7½	88 0	88 4½	88 6	95 2½
1925	87 5	85 9	84 7½	82 6	80 10½	79 3	77 1½	75 7½	75 0	74 3½	74 9	76 0	79 5½
1926	77 8	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 5½	81 7½
1927	90 0	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 6	72 9	71 9	71 1½	79 2½
1928	69 7½	69 7½	69 9	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	74 0	74 1½	74 9	75 6	76 1½	76 8½	78 1½	79 0	74 11½
1930	78 2½	78 0	76 9	75 0	74 0	72 7½	71 0	71 0	71 0	71 0	70 10½	70 4½	73 3½
1931	70 0	69 0	68 0	66 8½	65 1½	63 4½	62 9	61 1½	65 0	65 0	65 0	65 0	65 6
1932	64 10	64 3	63 6	63 6	63 6	62 7½	62 0	60 6	60 0	59 3	59 0	59 0	61 10

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All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
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ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

BRASS FOUNDRY FOREMAN desires position; experienced in Admiralty contracts, gunmetal, phos. bronze and manganese castings; 12 years foreman in last situation.—Box 258, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Fully-qualified Analyst for Cast-iron Foundry. State age, experience, salary required.—Box 310, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

GREY-IRON Foundry with small steel-casting department has vacancy for Foreman used to production of small steel castings.—Give full particulars, age, experience, salary, etc., Box 312, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

PRACTICAL Foundryman seeks situation in any sphere of foundry activity. Excellent character, secondary education. Contributor to foundry literature, many educational successes. Preferably situation of trust and responsibility. Representative foundry requisites. Anything considered; not afraid of work. (201)

FIRST-CLASS Steel-Foundry Manager requires similar position, or in any other capacity where experience could be utilised. Sound engineering training, practical steel-making, experience including electric steel and subsequent manager of well-known steel foundries. (202)

YOUNG Moulder, 19 years of age, requires position. Good experience on special pipes and similar castings. (203)

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THOS. W. WARD, LTD.

DROP HAMMERS, cap. 5-, 3- and 2-cwt. sizes.

GENERATING SET, 20 kw., Petrol dr., 4 cyl., 110 v., 750 revs.

RUMBLER, 15′ x 4′ x ¼″ thick, hinged door.

2 Nearly New BABCOCK LAND-TYPE WATER-TUBE BOILERS, 2,530 sq. ft. heating surface; 160 lbs. w.p.; with superheaters and underfeed stokers.

Write for "Albion" Catalogue.

'Grams: "Forward, Sheffield."

'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued.*

MORRIS Cupola Hoist with Steel Tower and Car.—A. MORGAN, 50, Wilkin Street, N.W.5. Gul. 1147.

FOR SALE.

SAND BLASTING PLANTS.

TILGHMAN Sand Blast Room, 12 ft. x 9 ft., complete with Air Compressor.

TILGHMAN Rotary Barrel Sand Blast, 36 in. x 30 in., complete with Air Compressor.

TILGHMAN DOUBLE BARREL Rotary Sand Blast, barrels 24 in. x 20 in., complete with Air Compressor.

TILGHMAN CABINET Sand Blast, cabinet 4 ft. 6 in. square. Sand Apparatus stands on floor, no pit required; complete with Air Compressor.

JACKMAN Rotary Barrel Sand Blast, barrel 30 in. x 24 in., complete with Air Compressor.

MOULDING MACHINES.

FARWELL Type Hand SQUEEZERS, plain and universal, also with turnover, sizes 30 in. and 36 in., by Adams.

FARWELL Type Hand Squeezers, 24 in., by Samuelson.

ADAPTABLE HAND Moulding Machines, latest type.

Also Pneumatic Jolters, Jolt Squeezers, etc., etc.

All types of Foundry Plant, Air Compressors, etc., in stock. Low prices.

Send your inquiries to:—

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ELEC. Travelling Wharf Crane. All motions. Cheap.—A. MORGAN, 50, Wilkin Street, N.W.5. Gul. 1147

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Power and Hand Moulding Machines, Sand Mills and Disintegrators, Sand Blast Plants, Ladles, Melting Furnaces, Grinding Machines, Blowers and Exhaust Fans, Air Compressors, etc., etc.

Also 300 A.C. and D.C. Electric Motors, ¼ to 200 h.p., and Generators, to suit most systems.

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'Phone: Bearwood 1103.

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with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,

ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

FOUNDRY SPRIGS, English, fine cut, now further reduced. Please write us for carriage-paid rates, stating quantities.—WILLIAM OLSEN, LIMITED, Cogan Street, Hull.

MISCELLANEOUS—*Continued*

SPRIGS (fine cut) at cut prices; 3 in. to 6 in., £11 10s. ton d/d any station England, or 11s. 6d. cwt., carriage extra.

Inquiries esteemed.

ROBERTS METALLURGICAL COMPANY, 30, Ravenswood Road, Balham, London, S.W.

'Phone: 287 SLOUGH

HAND MOULDING MACHINES

Six Standard "Adaptable" machines £12 each

Two "LARGE" Adaptables (take 30″×30″) ... ... £15 each

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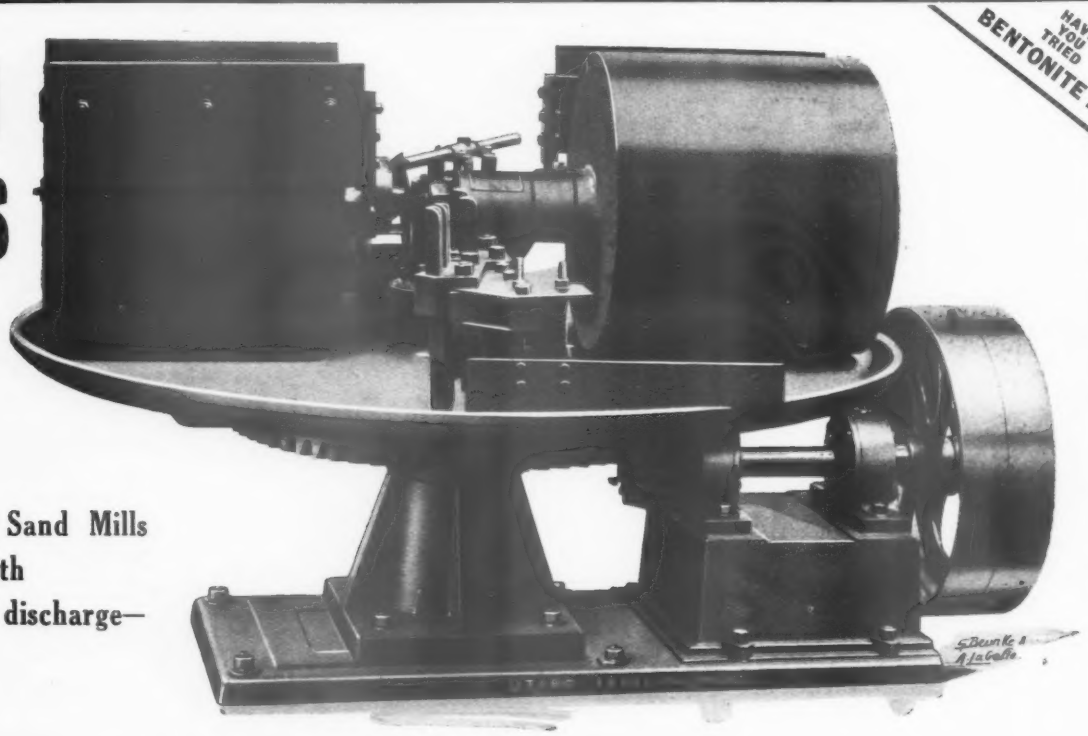

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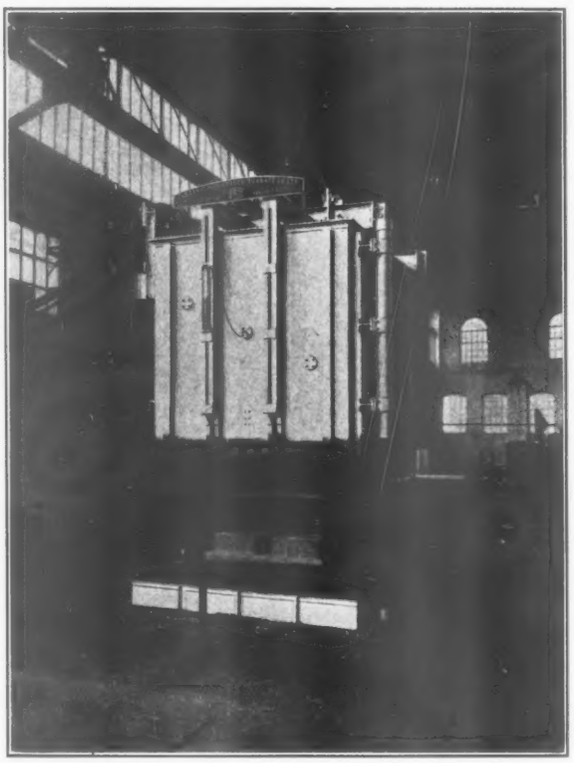

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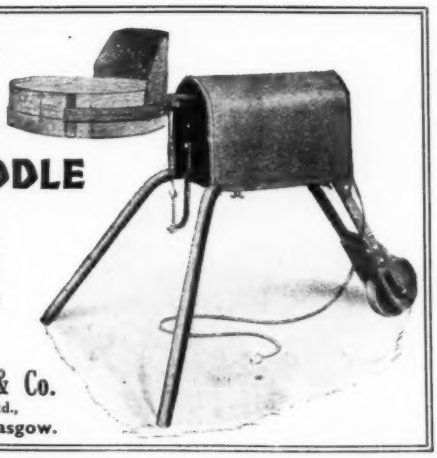

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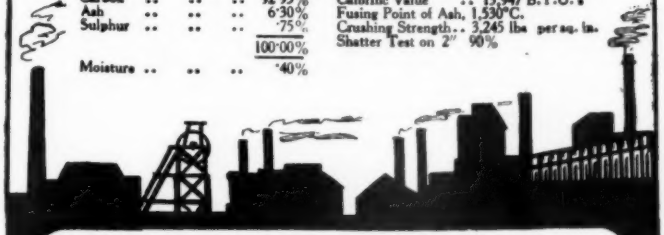

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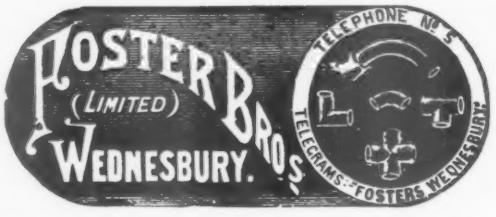

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